

PROJECT MANUAL

**AMITY REGIONAL SCHOOL DISTRICT #5
CONNECTICUT**



MEDIA CENTER INTERIOR ALTERATIONS

**AMITY REGIONAL HIGH SCHOOL
25 NEWTON ROAD
WOODBIDGE, CT 06525
PHASE 1 OF 2**

**BID #2026-LMC-HS-1
STATE PROJECT #205-0046 A
S/P+A PROJECT #23.195**

VOLUME 1 OF 1

**CD Submission: November 7, 2025
Issued for Bid: May 1, 2026**



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LEGAL NOTICE

INVITATION TO BID

**Amity Regional School District #5
Amity Regional High School Media Center Interior Alterations
Bid #2026-LMC-HS-1
State Project #205-0046 A**

Amity Regional School District #5 ("RSD5") is soliciting sealed bids from responsible qualified contractors for construction and related services for interior renovations, alterations, improvements, and associated work to the media center at Amity Regional High School located at 25 Newton Road, Woodbridge, CT 06525 (the "Project"). Bidders are required to be pre-qualified by the Connecticut Department of Administrative Services ("DAS") for work in the following classification: GENERAL BUILDING CONSTRUCTION (GROUP B).

Sealed bids with the words **"SEALED BID –SEALED BID – Amity Regional High School Media Center Interior Alterations Project – Bid #2026-LMC-HS-1"** and the bidder's name and address all clearly marked on the outer envelope, must be received by received by RSD5 at the office of the Director of Finance at the District's Administrative Offices located at 25 Newton Road, Woodbridge, CT 06525, no later than 2:00 p.m. EST on Friday, June 5, 2026, at which time bids received will be publicly opened and read aloud. In the event of the closure of the District's Administrative Offices on date noted above, bids will be opened and read aloud at 2:00 p.m. EST on the next business day that the Administrative Offices is open. Any bid received after the time and date specified shall not be considered. Bid submissions must be delivered in hard copy by mail, or by hand delivery, and shall include an original and three (3) copies.

Opening of Bids will also be held publicly using 'Zoom' at the following link: <https://zoom.us/j/95960232375?pwd=NzFoN1hmWVZiNUoyckJseHhKbE1oQT09>; Meeting ID: 959 6023 2375; Password: 320443. One tap mobile: +19292056099,,95960232375# US (New York), +13017158592,,95960232375# US (Germantown); Dial by your location +1 929 205 6099 US (New York) or +1 301 715 8592 US (Germantown). Meeting ID: 959 6023 2375. Find your local number: <https://zoom.us/u/ajZDtDvp8>

The Invitation to Bid, Instructions to Bidders, drawings, specifications, and other Bidding Documents (as defined in the Instructions to Bidders) may be accessed on the Department of Administrative Services (DAS) website <https://portal.ct.gov/das/ctsource/bidboard> under the State Procurement Marketplace, State Contracting Portal ("DAS Website"). To access the documents, click on the Contracting Organization, Cities, Towns and Municipalities, "Regional School District #". Bidding Documents will also be available on the Amity Regional School District Website at: www.amityregion5.org ("District Website"). Each bidder is responsible for checking the District Website and/or the DAS Website to determine if any addenda to the Bidding Documents have been issued.

A mandatory pre-bid Project site visit will be conducted at the Project site at 1:30 p.m., on Tuesday, May 12, 2026, at the Amity Regional High School located at 25 Newton Road, Woodbridge, CT, for all interested bidders. The site visit will begin at the main entry of the school building. Please confirm attendance at the site visit and request instructions for the site visit by email to Director of Facilities Stephen Martoni at stephen.martoni@amityregion5.org.

Any questions and official Requests for Information (RFI) by interested bidders regarding this Invitation to Bid shall be submitted in writing in accordance with the Instruction to Bidders and other Bidding Documents.

Except as otherwise expressly provided in the Instructions to Bidders, a Bid Bond in an amount equal to five percent (5%) of the total Bid amount must be submitted with each Bid. The selected contractor shall be required to provide performance and labor and material payment bonds each in the amount of the total contract price.

This Project is subject to the prevailing wage law requirements of Connecticut General Statutes (CGS) Section 31-53, et seq. Current prevailing wage rate information is included with the Bidding Documents.

This contract is partially funded by a school building project grant from the State of Connecticut under the DAS school construction grant program for public schools. This Project is subject to the prevailing wage requirements of CGS Section 31-53, et seq. This contract is subject to state contract compliance requirements, including spending allocation goals (25% SBE and 6.25% M/W/DisBE) and non-discrimination requirements enforced by the Commission on Human Rights and Opportunities.

RSD5 reserves the right to amend or withdraw this Invitation to Bid for any reason, to accept or reject any or all Bids, to waive any informalities or non-material deficiencies or irregularities in any Bid, and to make such award (or make no award) of a contract in connection with this Invitation to Bid all as determined by its Board of Education, in its discretion, to be in the best interest of RSD5 and the Board of Education.

A Bid may be rejected for irregularities of any kind, including without limitation, alteration of form, additions not called for, conditional proposals, and incomplete Bids. The foregoing provisions are for illustrative purposes and shall in no way limit the right of RSD5 and its Board of Education to reject any or all Bids, in whole or in part. Any contract awarded in connection with this Invitation to Bid shall be awarded to the lowest responsible qualified bidder.

Amity Regional School District #5 is an Equal Opportunity Employer. Minority Business Enterprises (MBE) and Women's Business Enterprises (WBE) are encouraged to bid.

1. PROJECT DESCRIPTION

The Work for the Project generally consists of interior renovations, alterations, and improvements to the media center at Amity Regional High School located at 25 Newton Road, Woodbridge CT 06525 (the “**Property**”) as shown on and required by the Bidding Documents for the Project, and will include all labor, materials, equipment, and incidentals necessary to complete the construction of the Project in accordance with, and more particularly described in, and as may be reasonably inferable from the Bidding Documents. The specific work for this Project will be defined and included within the Contract Documents. The Project Owner is Amity Regional School District #5 (“Owner”).

2. PROJECT SCHEDULE

It is anticipated that the successful bidder awarded a contract for the Project (the “Contractor”) will commence construction of the Work no later than June 16, 2026 to prepare the construction safety zones and Contractor staging areas at the Project site and that the Contractor must begin coordination and submit shop drawings and submittals for approval of ordering equipment and materials prior to that date; achieve substantial completion of the entirety of the Work no later than December 31, 2026; and that final completion of the Work and the entirety of Project will be achieved, including punch list and demobilization, no later than March 1, 2027.

The Contractor will be encouraged to commence acquisition of all materials needed to perform the Work immediately after execution of the contract for construction for the Project between the Owner and the Contractor (the “Contract” as defined in Section 14 of these Instructions to Bidders”), to ensure all materials are on hand when on site construction begins. It is anticipated that the Notice to Proceed will be issued by the Owner at the time of the Contract is awarded and executed.

The Contractor will be permitted to perform the Work at the Project site during the work hours of 6:00 a.m. to 10:00 p.m., Monday through Saturday, excluding holidays; provided that requests to perform the Work outside of the normal hours may be requested by the Contractor and coordinated with the Owner. Construction activities will be confined to the immediate work area at the Project site only, and additional areas that may be designated by the Owner upon request by the Contractor.

Each bidder shall include as part of its bid submission a complete and realistic proposed construction schedule, including the trades activities, equipment, and materials for the Work consistent with the Owner’s anticipated schedule for the Project.

3. IMPORTANT DATES

Advertisement of Invitation to Bid:	May 1, 2026
Mandatory Project Site Visit with Interested Bidders:	May 12, 2026, 1:30 p.m.
Deadline for Submission of Questions and Requests for Information:	May 18, 2026, 10:00 a.m.
Responses to Requests for Information:	May 20, 2026, 3:00 p.m.
Deadline for Bid Submission:	May 27, 2026, 2:00 p.m.
Interviews of Prospective Bidders:	TBD
Selection of Successful Bidder/Letter of Intent to Award:	June 8, 2026, 7:00 pm.
Anticipated Contract Execution:	By June 15, 2026
Commencement of Work:	By June 16, 2026
Final Completion:	By December 31, 2026
Submission of Final Payment Application:	April 30, 2026

4. BIDDING DOCUMENTS

The Bidding Documents shall include the Invitation to Bid, these Instructions to Bidders and all Schedules to these Instructions to Bidders listed below, all addenda issued prior to the opening of Bids, and all other

documents identified as “Bidding Documents” in these Instructions to Bidders (the “**Bidding Documents**”). The Bidding Documents include, without limitation:

- A. Invitation to Bid/Legal Notice
- B. Instructions to Bidders with included Schedules:
 - 1. Schedule 1: Non-Collusion Affidavit
 - 2. Schedule 2: Corporate Resolution
 - 3. Schedule 3: List of Required Bid Submission Documents
 - 4. Schedule 4: Standard Bid Bond Form
 - 5. Schedule 5: Statement of Qualifications
 - 6. Schedule 6: Certificate of Compliance Re Connecticut General Statutes Section 31-57b
- C. Bid Form
- D. Form of Contract for Construction: AIA A101-2017 Agreement, as modified by the Owner, with Exhibit A-Insurance Requirements
- E. General Conditions: AIA A201-2017, as modified by Owner
- F. Supplementary General Conditions
- G. Project Application and Project Certificate for Payment (AIA G702)
- H. Project Application Continuation Sheet (AIA G703)
- I. Prevailing Wage Rate Information
- J. 2025-26 and 2026-27 School Calendars
- K. Drawing List
- L. All Specifications listed on the Table of Contents
- M. All Drawings listed on the Drawing List
- N. All Addenda issued by the Owner prior to the Bid Submission Deadline

Bidders shall use complete sets of Bidding Documents in preparing Bids. The Owner assumes no responsibility for errors or misinterpretations resulting from any bidder's use of incomplete Bidding Documents.

The Owner reserves the right to amend the Bidding Documents by issuance of Addendum as deemed necessary, appropriate, or otherwise in the best interest of the Owner.

5. NON-COLLUSION STATEMENTS

In order for any Bid to be considered, a non-collusion affidavit must be submitted with the Bid. A sample non-collusion affidavit is included as part of the Bidding Documents attached, provided, bidders may elect to submit their own notarized non-collusion affidavit.

6. PROJECT PRICING

The compensation to be paid to the Contractor for the performance of the Work for the Project shall be based on lump sum prices and unit prices for the Work. The Contractor will be required to obtain its own Town and building permits at no additional charge to the Owner. Town of Woodbridge permits can be obtained from the Town of Woodbridge at NO cost to the Contractor, excluding the State Education permit cost of \$0.26/\$1,000 value. As the Work progresses, the Owner or the Contractor may identify additional Work or repairs required for the Project, as noted. On each bidder's Bid Form, the bidder shall provide a lump sum price for the designated Work as the Base Bid Amount, unit prices for possible additional work that may be identified during the course of construction of the Project as the Unit Price Bid Amounts, as well as Allowance Bid Amounts and Alternates Bid Amounts for the Work as set forth on the Bid Form. The selected Contractor shall not conduct any additional work or Unit Price Work without prior approval written approval of the Owner.

7. CHANGE ORDERS

Any deviations from, additions to, or deductions from either scope of the Work under the Contract or the Contract Sum thereunder, or changes in the scope of the Work involving unit price work items, shall be submitted by the selected Contractor to the Owner in accordance with Contract and the Contract Documents. All changes in scope of Work involving unit price work items shall be governed by the Unit Price Bid Amounts established the Contract between the Owner and the Contractor. Refer to the General Conditions and Section 012600 "Contract Modification Procedures".

8. RETAINAGE

Retainage in the amount of five percent (5%) shall be withheld by the Owner from all progress payments, and five percent (5%) of the final contract price for a period not to exceed sixty (60) days after the date of final acceptance of the Project by the Owner.

9. BID SUBMISSIONS

- A. Bids received after the Bid Submission Deadline (as it may be adjusted by Addenda) will not be considered and will be returned unopened.
- B. All Bids must be submitted on forms included or identified in these Instructions to Bidders or the other Bidding Documents. The Owner reserves the right to reject any Bid submission which reflects omissions, alterations of form, additions not called for, conditional or alternate Bids, or irregularities of any kind. All blank spaces in the Bid Form included in the Bidding Documents, must be filled in (typed or printed in ink) completely, correctly, and legibly, and all prices and quantities must be inserted where indicated. If any price or quantity is omitted, the Bid may be rejected. "Ditto" marks are not considered writing or printing and shall not be used. All Bids must be based on the exact materials and/or equipment specified in the Bidding Documents and referenced on the Bid Form. Bids containing different materials or equipment models than those specified will be considered non-responsive. A properly authorized representative of the bidder must sign the Bid submission where indicated. If the proposal is made by an individual, the individual's name and mailing address must be listed. If made by a partnership, limited liability company or a corporation, the Bid must be signed by an official of the partnership, limited liability company, or corporation authorized to sign contracts, and must reflect the mailing address of the partnership, limited liability company, or corporation. Bids may not be submitted and will not be accepted if made orally (e.g. via telephone), by facsimile, or by e-mail bids.

Bidders are encouraged to "double check" and verify all pricing submitted as part of their Bid. An award of the contract to the selected Contractor based on other pricing submitted by a bidder in error, will nonetheless be deemed by the Owner to be a firm Bid by the bidder. "Adjustments" to correct any errors in Bid pricing may not be made to any Bid after the Bid is opened.

- C. All Bid submissions must include one (1) original and three (3) paper copies of the documents listed on **Schedule 3 - List of Required Bid Submission Documents**. Any Bid which fails to include all the required documents and information may be deemed non-responsive and invalid.
- D. All Bids must be submitted in the form and manner required by the Bidding Documents. Any Bid not submitted in the form and manner required by the Bidding Documents, or Bid which contains information, statements, conditions, or qualifications which place conditions or qualifications on a Bid for purposes of making an award of the Contract, or Bid which purports to alter any Bid Form terms, conditions, specifications, or forms that are part of the Bidding Documents, or Bid which fails to comply with all applicable legal requirements, shall be deemed non-responsive and invalid. Any Bid that does not fully respond to and comply with all requirements of the Bidding Documents for the

submissions of Bids, may be deemed non-responsive and rejected by the Owner. The Owner shall not be responsible for any errors or omissions of any bidder in their Bid.

- E. The Owner reserves the right to reject any Bid in which unit prices or other pricing are, in the sole opinion of the Owner, unbalanced.

10. QUESTIONS, INTERPRETATIONS & ADDENDA

Any questions and requests for interpretation or information (collectively, "RFIs") from any prospective bidder regarding the Invitation to Bid, these Instructions to Bidders, or other Bidding Documents, must be submitted in writing and, to be given consideration, must be received in accordance with the timeline included in Section 3 above. Responses to all RFIs will be provided by written Addenda to the Bidding Documents. Addenda including such responses will be published on the DAS Website and the District Website in accordance with the timeline included in Section 3 above. Addenda, once published, will become a part of the Bidding Documents.

RFIs shall be submitted in writing via e-mail to Director of Facilities Stephen Martoni at stephen.martoni@amityregion5.org, in accordance with the timeline included in Section 3 above to be considered. RFIs that are not submitted in accordance with this Section 10 will not be answered. RFIs answered other than by formal written Addenda published in accordance with this Section 10 will not be binding on the Owner and will be without legal effect.

EX-PARTE COMMUNICATION: To ensure the bidding process for the Project is accordance with applicable law, the Owner prohibits *ex parte* communication between any prospective bidder or bidder with any officer, consultant, employee, representative and/or member of the Owner, the Amity Regional School District #5 Board of Education, and/or Amity Regional School District #5 High School Library Media Center Building Committee involved in the evaluation of Bids or award of the Contract to the selected Contractor which relates to the Bidding Documents or the Project, other than communications for the submission of an RFI, from the date of the Invitation to Bid until a decision to award a contract in connection with the Invitation to Bid (or to award no contract) has been made. Prohibited *ex parte* communications may be grounds for disqualifying the offending bidder from consideration of their Bid.

Addenda to the Bidding Documents will be issued by the Owner in accordance with the timeline included in Section 3 above, as it may be adjusted in the discretion of the Owner. Addenda will become part of the Bidding Documents on the date published. It is the responsibility of each prospective bidder to check the DAS Website and the District Website from time to time to confirm whether any Addenda have been published. Lack of knowledge of a bidder of any Addenda that have been published as described above, shall not relieve the bidder from its obligations under its Bid submission.

Each bidder shall confirm in writing as required on the Bid Form submitted as part of its Bid that the bidder is aware of and has reviewed all Addenda issued.

11. SITE CONDITIONS/PRE-BID PROJECT SITE VISIT

A mandatory pre-bid Project site visit will be conducted at the Project site in accordance with the timeline included in Section 3 above. Interested parties should meet at the entrance of the school building to sign in and collect temporary visitor badges. Visitor parking spaces are available. No visitors will be allowed on the school Property without an escort. No bid shall be considered responsive by the Owner unless the bidder shall have attended the mandatory pre-bid Project site visit.

Each bidder shall fully inform themselves prior to bidding as to the existing conditions for the Project site. By submission of its Bid, each bidder represents that the bidder has: (i) made an examination of the Project Site; (ii) satisfied itself as to actual conditions of the Project Site and the requirements and scope of the Work required to be performed for the Project; (iii) considered Federal, State, and local laws and

regulations that may affect cost, progress, performance, or furnishing of the work for the Project; and (iv) reviewed and become thoroughly familiar with the Bidding Documents including, without limitation, the Drawings and Specifications for the Project included in the Bidding Documents.

12. MODIFICATIONS/WITHDRAWALS OF BIDS

Bid Withdrawal: Bids may be withdrawn at any time prior to the Bid Submission Deadline (as it may be adjusted by Addenda), by submitting a written request to withdraw to Theresa Lumas, Director of Finance. Upon receipt of such request, if timely, the original Bid will be made available, unopened, to the bidder at the Office of the Director of Finance. Bids withdrawn prior to the Bid Submission Deadline may be resubmitted up to the Bid Submission Deadline provided such resubmitted Bids are then fully in conformance with these Instructions to Bidders. After the opening of Bids, no bidder may withdraw its Bid for a period of ninety (90) days thereafter.

Bid Modification: Bids may be modified by written notice signed by the bidder prior to the Bid Submission Deadline. Such notice shall be accepted only if duly executed and submitted in the same manner as required in these Instruction to Bidders for the submission of Bids.

Bid Clarification: The Board reserves the right to request clarifications from any bidder. Such clarifications shall be provided at the bidder's sole cost and expense.

13. SELECTION PROCESS

A. Basis for Selection:

1. **Lowest Responsible and Qualified Bidder** - It is the intent of the Owner to award the Contract for the Project to the "lowest responsible and qualified bidder" which is the bidder (i) whose Entire Project Lump Sum Base Bid Amount set forth in its Bid Form is the lowest of those bidders possessing the skill, ability, and integrity necessary to faithful performance of the Work based on objective criteria considering past performance and financial responsibility; and (ii) whose Bid was submitted in accordance with the requirements set forth in the Bidding Documents. The bidder will be required to establish to the satisfaction of the Owner that the persons or entities proposed to furnish and perform the Work described in the Bidding Documents are reliable, responsible, and capable. To the extent that the Bid Form asks for alternate bids, the Owner's determination of the lowest Bid will be based on the sum of the Base Bid Amount and the Alternate Bid Prices for the alternates that are selected by the Owner for acceptance as determined by the Owner to be in the best interest of the Amity Regional School District #5.
2. **Statement of Qualifications** – It is the intent of the Owner to award the contract for the Project to a Contractor having broad experience in the various types of construction Work required by the Bidding Documents for the Project. To assist the Owner in its determination as to whether a bidder is qualified to perform the Work for the Project, **each bidder shall submit a Statement of Qualifications including the information set forth in Schedule 5 to these Instructions to Bidders along with all required supporting documentation.** Qualifications for the Project will include, without limitation, that:
 - a. Bidder's experience includes successfully completing, as general contractor and/or construction manager, a minimum of five (5) similar projects in Connecticut, within the past ten (10) years, which projects were of similar size, scope and complexity, as the Project.
 - b. All project personnel to be engaged in the Work shall be trained in accordance with OSHA Regulations applicable to the Work of the Project.
 - c. Bidder must be registered, as an entity, to do business in the State of Connecticut and employ individuals that are properly licensed to perform the Work.
 - d. **Bidder must be pre-qualified as provided in Section 19 of these Instructions to Bidders.**

3. Selection Criteria:

- a. Bidder's experience as a general contractor and/or construction manager in the successful completion of projects of similar scope, complexity and size as the Project, within budget, and on time, and with integrity and reliability; or the bidder's its inability to do so;
 - b. Bidder's capacity to perform the Project considering bidder's ongoing and future obligations;
 - c. Bidder's credit history and financial stability;
 - d. The experience of the bidder's project team proposed to be used for the Project in the successful completion of projects of similar scope and size within budget and on time;
 - e. The ability of the bidder to provide the required surety bonds;
 - f. The ability and capacity of the bidder to perform the Work based on an evaluation of the character, integrity, reputation, and experience of the bidder;
 - g. The financial resources of the bidder and the bidder's ability to secure any required bonds and/or insurance;
 - h. Compliance by the bidder with all applicable federal, state, and local laws, including any licensing requirements and/or contract compliance requirements;
 - i. Delivery or completion time;
 - j. Cost; and
 - k. Involvement in litigation.
4. Investigation – The Owner reserves the right to make any investigation to further determine the ability of any bidder to perform and complete the obligations of the selected Contractor under the Contract Documents and other Bidding Documents, and any bidder shall furnish to the Owner all such information and data for this purpose as are required under the Bidding Documents.
 5. Interviews – The Owner reserves the right to conduct interviews with one (1) or more of the bidders at a time and date to be determined by the Owner. If a bidder is requested by the Owner to attend an interview, the attendees representing the bidder shall include one (1) or more representatives of the bidder capable of responding to questions regarding the Bid submitted as well as the proposed superintendent/project manager for the Project.

B. Selection and Award:

1. The bidder selected for the Project, if any, will be the bidder determined by the Owner to be the lowest responsible qualified bidder, qualified and capable of performing the work for the Project in accordance with the requirements of the Bidding Documents, based on the Selection Criteria set forth in Section 10(A) and the entirety of such bidder's Bid submission.
2. Upon identifying the successful bidder, the Owner will send a written notice of intent to award the Contract to such bidder. Notwithstanding receipt of such notice of intent to award, the Owner shall have no obligation to such bidder until such time as a Contract (as defined in Section 14 hereof) is fully executed and delivered.
3. The Owner reserves the right to do any of the following without liability, as deemed by the Regional School District #5 Board of Education and Owner to be in the best interest of the Owner:
 - a. Reject any and all Bids, in whole or in part, for misrepresentation or if the Bidder is deemed to be not qualified or responsible to perform the Project, or if the bidder's Bid limits, conditions or modifies any of the terms and conditions and/or specifications of the Bid;
 - b. Cancel the award to the lowest responsible qualified bidder, or, not to execute the Contract subsequent to award;
 - c. Terminate or cancel the Invitation to Bid and reject all Bids, and/or rebid the Project by advertising for new bids;
 - d. Waive technical defects, irregularities, and omissions in a Bid if, in the Owner's discretion, the best interest of the Regional School District #5 Board of Education and Owner would be served;

- e. Revoke the award of the Contract if such award was made on the basis of inaccuracies and clerical errors; and
- f. Reject a Bid as non-responsive if the bidder does not make all required pre-award submittals within the timeframes designated by the Owner.

14. FORM OF CONTRACT

The Owner intends to use as the Form of Contract for the Contract for Construction, and the selected Contractor will be expected to execute, a modified version of AIA Document A101-2017 Agreement (as so modified, the "Agreement") with an Exhibit A (Insurance Requirements), and a modified version of AIA Document A201-2017 General Conditions (as so modified, the "General Conditions"), and exhibits and other documents designated therein as "Contract Documents." **The form of Agreement and General Conditions are included as part of the Bidding Documents.** Bidders should review the aforementioned documents. By submitting a Bid, the bidder warrants and certifies that if the bidder is awarded the contract for this Project, the bidder will execute the aforementioned Contract Documents without condition, modification, or exception, except as required to incorporate the acceptable terms of the selected Contractor's Bid (the "Contract"). The selected Contractor shall execute the Contract within ten (10) days after presentation thereof by the Owner to the selected Contractor and the Contractor shall include the provisions of the Contract in each subcontract issued by the Contractor for the Project, with the applicability of terms to be adjusted appropriately. Notwithstanding the foregoing, the Owner reserves the right to modify the Form of Contract prior to execution of the Contract as deemed by the Owner to be in the best interest of the Regional School District #5 Board of Education and Owner. If the selected Contractor fails to execute the Contract within ten (10) days after presentation of the Contract by the Owner, the selected Contractor shall forfeit its Bid Security and, at the option of the Owner, the award of the Contract shall be withdrawn and become null and void. The Owner may then proceed to award the Contract to the next lowest responsible qualified bidder.

15. BID SECURITY

Except as otherwise provided in this Section 15, each Bid must be accompanied by a bid bond in the form attached hereto as Schedule 4, in an amount equal to five percent (5%) of the Base Bid Amount set forth on the Bid Form submitted by the bidder, executed by the bidder and a surety authorized to issue surety bonds in the State of Connecticut, that is listed on the current U.S. Department of Treasury's Listing of Approved Sureties, and that has a rating of A- or better by A.M. Best. In lieu of a Bid Bond, a bidder may submit a certified check, cashier's check, Treasurer's check, or money order in the same amount as required for a Bid Bond, payable to the "Amity Regional School District #5".

If the bidder is a small contractor or a minority business enterprise as defined by Connecticut General Statutes (CGS) Section 4a-60g, the bidder may, in lieu of providing a Bid Bond, certified check, cashier's check, Treasurer's check, or money order as bid security, provide a letter of credit in an amount equal to five percent (5%) of the Base Bid Amount if the Base Bid Amount is less than One Hundred Thousand Dollars (\$100,000), or an amount equal to twenty-five percent (25%) if the Base Bid Amount exceeds One Hundred Thousand Dollars (\$100,000.00).

Bids submitted without bid security in accordance with this Section 15 will be deemed non-responsive and invalid.

All forms of Bid Security submitted by bidders other than those determined be the lowest three (3) bidders, will be returned within ten (10) days after the date of opening of Bids.

Bid Security submitted with Bids by bidders determined to be among the three (3) lowest bidders will be retained by the Owner until one (1) of the three (3) lowest bidders is awarded and executes a contract with the Owner for the Project, or until all Bids are rejected. If the bidder selected as the Contractor fails or refuses to execute the Contract in accordance with its Bid and the Bidding Documents after notice by

the Owner that the Contract has been awarded to the selected bidder, an amount of the bidder's Bid Security shall be deemed forfeited by the bidder to the Owner and/or the bidder and its surety issuing a Bid Bond shall be required to perform their obligations under such Bid Bond.

The Owner shall not be liable for the accrual of interest on any certified deposit check submitted in lieu of a Bid Bond.

Subject to the Owner's rights to retain Bid Security as a forfeiture by the selected Contractor and/or enforce such Bid Security, all Bid Security not already returned or refunded to bidders will be refunded or returned to the unselected bidders after the earlier of (1) the Owner's withdrawal and/or cancellation of the Invitation to Bid; (2) the award and execution of the Contract by the Owner to and with a bidder selected as the Contractor, or (3) ninety (90) days after the date of opening of Bids.

16. TAXES

The Project is tax exempt. Upon request, the Owner will furnish the successful bidder a sales tax exemption letter.

Certain materials and supplies incorporated in the Work for this Project are exempt from Connecticut sales and use tax. State sales and use taxes are excluded except for taxes on rentals, tools, and other incidentals as determined by the State Department of Revenue and for which the successful bidder is responsible. The successful bidder shall familiarize themselves with current regulations of the State of Connecticut Department of Revenue Services. The tax on materials or supplies exempted by such regulations shall not be included as part of the Bid.

17. PAYMENT BOND AND PERFORMANCE BOND REQUIREMENTS

- A. Except as provided in subparagraph C of this Section 17, the Contractor will be required to provide a performance bond and labor and material payment bond, in an amount not less than one hundred percent (100%) of the total contract price set forth in the Contract. The bonds must be issued by a surety rated A- or better by A.M. Best and listed on the U.S. Department of Treasury's Listing of Approved Sureties. The bonds must be submitted to the Owner prior to or upon the execution of the Contract. The cost of such bonds shall be separately identified on the Bid Form but included in the total Bid amount.
- B. The bonds shall comply with the following requirements:
 - 1. It is preferred that the bonds be written on the AIA Document A312-2010 forms. Both bonds shall be written in the full amount of the Contract Sum.
 - 2. The bonds shall be dated the same date as the Contract.
 - 3. The Amity Regional School District #5 shall be named as the obligee on all bonds provided for the Project.
 - 4. The Contractor shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of the power of attorney.
- C. If the Contractor is a small contractor or a minority business enterprise as defined by CGS Section 4a-60g, the Contractor may: (1) in lieu of providing performance bond, provide a letter of credit in an amount equal to ten percent (10%) of the Contract Price if the Contract Price is less than One Hundred Thousand Dollars (\$100,000.00), or an amount equal to twenty-five percent (25%) if the Contract Price if the Contract Price exceeds One Hundred Thousand Dollars (\$100,000.00), and; (2) in lieu of providing a labor and material payment bond, provide a letter of credit in an amount equal to ten percent (10%) of the Contract Price if the Contract Price is less than One Hundred Thousand Dollars (\$100,000.00), or an amount equal to twenty-five percent (25%) if the Contract Price if the Contract Price exceeds One Hundred Thousand Dollars (\$100,000.00).

- D. Each bidder shall furnish with its Bid, satisfactory evidence from its surety of such bidder's ability to obtain the required performance bond and labor and materials payment bond, in the full amount of the bidder's total Base Bid Amount, or, satisfactory evidence that it is a small contractor or a minority business enterprise as defined by CGS Section 4a-60g together with satisfactory evidence of its ability to provide to the Owner a letter of credit in lieu of the required performance bond and/or a letter of credit in lieu of the required labor and material payment bond.
- E. A labor and material payment bond will be required from all subcontractors, except that in accordance with CGS Section 49-41(a), a labor and material payment bond shall not be required to be furnished in relation to any sub-bid in which the total estimated cost of labor and materials under the subcontract with respect to which such sub-bid is submitted is less than One Hundred Thousand Dollars (\$100,000.00).

18. LIQUIDATED DAMAGES

Liquidated damages shall apply as provided in the Contract. Liquidated damages may be assessed against the selected Contractor in the amount of Five Hundred and 00/100 Dollars (\$500.00) per calendar day that timely completion of the Work is delayed beyond the time(s) required in the Contract.

19. NON-DISCRIMINATION AND EQUAL EMPLOYMENT OPPORTUNITY COMPLIANCE REQUIREMENTS

- A. This Contract will be partially funded by a school building project grant from the State of Connecticut under the DAS school construction grant program for public schools. The contractor who is selected to perform this State project must comply with CGS Sections 4a-60, 4a-60g, and 46a-68b through 46a-68f, inclusive, and Sections 46a-68j-21 through 43 of the Regulations of Connecticut State Agencies (RCSA).
- B. In the Contract, the Contractor will be required to agree, pursuant to CGS Section 4a-60, as follows:

“(1) The contractor agrees and warrants that in the performance of the contract such contractor will not discriminate or permit discrimination against any person or group of persons on the grounds of race, color, religious creed, age, marital status, national origin, ancestry, sex, sexual orientation, gender identity or expression, status as a veteran, status as a victim of domestic violence, status as a victim of sexual assault, or status as a victim of trafficking in persons, intellectual disability, mental disability, or physical disability, including, but not limited to, blindness, unless it is shown by such contractor that such disability prevents performance of the work involved, in any manner prohibited by the laws of the United States or of the state of Connecticut; and the contractor further agrees to take affirmative action to ensure that applicants with job-related qualifications are employed and that employees are treated when employed without regard to their race, color, religious creed, age, marital status, national origin, ancestry, sex, gender identity or expression, sexual orientation, status as a veteran, status as a victim of domestic violence, status as a victim of sexual assault or status as a victim of trafficking in persons, intellectual disability, mental disability, or physical disability, including, but not limited to, blindness, unless it is shown by such contractor that such disability prevents performance of the work involved;

(2) The contractor agrees, in all solicitations or advertisements for employees placed by or on behalf of the contractor, to state that it is an “affirmative action-equal opportunity employer” in accordance with regulations adopted by the Commission on Human Rights and Opportunities (“CHRO”);

(3) The contractor agrees to provide each labor union or representative of workers with which such contractor has a collective bargaining agreement or other contract or understanding and each vendor with which such contractor has a contract or understanding, a notice to be provided by the Commission on Human Rights and Opportunities advising the labor union or workers' representative of the contractor's commitments under this section, and to post copies of the notice in conspicuous places available to employees and applicants for employment;

(4) The contractor agrees to comply with each provision of this section and sections 46a-68e and 46a-68f and with each regulation or relevant order issued by said commission pursuant to sections 46a-56, 46a-68e, 46a-68f and 46a-86; and

(5) The contractor agrees to provide the Commission on Human Rights and Opportunities with such information requested by the commission, and permit access to pertinent books, records and accounts, concerning the employment practices and procedures of the contractor as relate to the provisions of this section and section 46a-56.”

It shall be the responsibility of each bidder to be familiar with and knowledgeable about the non-discrimination Requirements.

- C. Spending Allocation Goal Participation: The Contract will be subject to State contract compliance requirements, including non-discrimination statutes and spending allocation goals. The Contractor who is selected to perform this State project must comply with CONN. GEN. STAT. §§ 4a-60, 4a-60g, and 46a-68b through 46a-68f. Connecticut State law requires a minimum spending allocation goal of twenty-five (25%) percent of the state-funded portion of the contract for award to subcontractors holding current certification from the Connecticut Department of Administrative Services under the provisions of CONN. GEN. STAT. § 4a-60g. (25% of the total state-funded value with DAS-certified Small Businesses and 6.25% of the total state-funded value with DAS-certified Minority-, Women-, and/or Disabled-owned Businesses.) The Contractor must demonstrate good faith effort to meet the spending allocation goals. The Contractor is responsible for ensuring the SBE/MBE firms that have been selected are eligible contractors. A Good Faith Efforts Plan must be filed by the contractor who is selected to perform this project with the CHRO within thirty (30) days following the intent to award notice, and must be approved by the CHRO prior to the award of the construction Contract. If required by CHRO, the contractor must file a written or electronic non-discrimination certification with the CHRO. Information and required forms can be found at: <https://portal.ct.gov/chro/contract-compliance/contract-compliance/contract-compliance-forms-and-reports>
- D. All provisions of all applicable State Labor Standards must be complied with under the Contract. The Amity Regional School District #5 and its Board of Education are an Affirmative Action Equal Opportunity Employer. The selected Contractor will not discriminate or permit discrimination against any person or group of persons on the grounds of race, color, religious creed, age, sex, gender identity or expression, marital status, national origin, ancestry, present or past history of mental disability, intellectual disability, learning disability, physical disability, including, but not limited to, blindness or status as a veteran except as permitted by law in the case of a bona fide occupational qualification or need. The selected Contractor shall provide CHRO with such information requested by the CHRO concerning the employment practices and procedures of the selected Contractor. The Bidder confirms and represents that it is an Equal Opportunity Employer.
- E. The selected Contractor shall provide any/all additionally required, affirmative action statements, fair employment plans and non-discrimination programs and statement as might be required by the Owner. In connection with the execution of its Bid, subsequent purchase orders, and/or contracts in connection with the Project, the selected Contractor shall not discriminate against any employee or applicant for employment on the grounds of race, color, religious creed, age, sex, gender identity or expression, marital status, national origin, ancestry, present or past history of mental disability, intellectual disability, learning disability, physical disability, including, but not limited to, blindness or status as a veteran except as permitted by law in the case of a bona fide occupational qualification or need, and shall otherwise comply with all laws and regulations of the State of Connecticut applicable to equal employment opportunities as pertains to municipalities.

20. PREVAILING WAGE REQUIREMENTS

- A. Prevailing wages are required on this Project in accordance with the Prevailing Wage Rate Information included in the Bidding Documents or as is otherwise required pursuant to applicable

Connecticut law, CGS Section 31-53 (a) through (h), as amended. For further information on prevailing wage requirements, visit the Connecticut Department of Labor's website.

- B. The selected Contractor and each subcontractor performing any Work for the Project shall be required to comply with the provisions of the CGS Section 31-53 and CGS Section 31-55a concerning annual adjustments to prevailing wages.
- C. The selected contractor and all subcontractors shall be responsible for identifying any adjustments made to Connecticut Department of Labor prevailing wage rate requirements throughout the life of the Contract. Such prevailing wage adjustments shall not be considered a matter for any Contract amendment or adjustment to the Contract Price. No escalation clauses shall be included in any Bid submission. Wage Rates will be posted each July 1st on the Department of Labor website: https://portal.ct.gov/dol/divisions/wage-and-workplace-standards/prevaling-wage?language=en_US
- D. The Contract shall provide, and the selected Contractor and subcontractors for the Project shall comply with the following: "The wages paid on an hourly basis to any person performing the work of any mechanic, laborer, or worker on the Work herein contracted to be done and the amount of payment or contribution paid or payable on behalf of each such person to any employee welfare fund, as defined in subsection (i) of Connecticut General Statutes Section 31-53, shall be at a rate equal to the rate customary or prevailing for the same work in the same trade or occupation in the Town of Woodbridge. Any contractor who is not obligated by agreement to make payment or contribution on behalf of such persons to any such employee welfare fund shall pay to each mechanic, laborer, or worker as part of such person's wages the amount of payment or contribution for such person's classification on each pay day."
- E. Certified Payrolls: In accordance with CGS Section 31-53, Certified Payrolls with a statement of compliance shall be submitted monthly by the Contractor to the Owner or its Project representative, and certified payrolls for the Contractor and all subcontractors working during the period shall be submitted with each Application for Payment submitted by the Contractor, covering all activities relating to such Application for Payment. The selected contractor shall provide pay scale verification as may be required by the Connecticut Department of Labor.
- F. Each bidder shall confirm prior to submission of its Bid that the bidder is carrying in its Bid and Bid Amount(s) the proper trade classification for all Work required for the Project including composite crews of different trade classifications if needed, as required by the Connecticut Department of Labor and/or union agencies if applicable.
- G. Forms and additional information can be found on the Connecticut Department of Labor's website.

21. NON-RESIDENT CONTRACTORS

Any bidder that is a Non-Resident Contractor shall be prepared, if identified as the selected contractor, to provide upon award of the Contract, a certificate from the Connecticut Commissioner of Revenue Services which evidences that the bidder has complied with the requirements of CGS Section 12-430(7). For further information, contact the Connecticut Department of Revenue Services.

22. DAS CONTRACTOR PREQUALIFICATION CERTIFICATION

Each bidder shall be pre-qualified by the Connecticut DAS as a Contractor for any project greater than \$500,000 and shall hold a current "DAS Contractor Pre-qualification Certificate" (not a pre-determination letter) from the Connecticut DAS according to and as required by CGS Section 4a-100, CGS Section 4b-101 and CGS Section 4b-91. **Each bidder shall submit with its bid, unless noted otherwise, a "DAS Contractor Pre-qualification Certificate" along with a current "Update (bid) Statement."** The required minimum prequalification classification is: GENERAL BUILDING CONSTRUCTION (GROUP B).

Any Bid submitted without a copy of the DAS Pre-qualification Certificate and an Update (Bid) Statement shall be deemed non-responsive and invalid. Contact the DAS Contractor Pre-qualification Unit at 860-713-5280 for more information.

23. INSURANCE REQUIREMENTS

The bidder selected as the Contractor will be required to purchase and maintain, without interruption, from the date of commencement of the Work until the date of final payment, and for the additional periods specified in the Bidding Documents, insurance in accordance with the requirements set forth in Exhibit A to the Form of Contract included in the Bidding Documents, and all insurance that may otherwise be required under any applicable laws. The selected Contractor shall submit to the Owner, certificates of insurance or other evidence of compliance with the insurance requirements set forth in Exhibit A to the Form of Contract included in the Bidding Documents, at the time and in the manner set forth therein.

The cost of the required insurance to the extent attributable to the Project shall be included in the Base Bid Amount of each bidder's Bid.

24. BACKGROUND CHECKS

The selected Contractor shall comply with all applicable laws including, without limitation, CGS Section 10-222c, as applicable. To the extent permitted by law, the selected contractor shall perform (or cause to be performed) as regards all of its employees, agents, and representatives (each, a "Contractor Employee"), and all of the employees, agents, and representatives of subcontractors and sub-subcontractors (each, a "Subcontractor Employee"), who will be physically present at the Project site in connection with the Project, appropriate background checks on all such Contractor Employees and Subcontractor Employees. Such background checks shall include, at a minimum and without limitation, a search of both the Connecticut Department of Emergency Services and Public Protection's sexual offender registry and the Abuse and Neglect Registry of the Connecticut Department of Children and Families.

SCHEDULE 1
BIDDER NON-COLLUSION AFFIDAVIT

STATE OF _____)
) ss: _____
 COUNTY OF _____)

I, _____ (affiant), being first duly sworn, deposes and says that:
 (name)

1. I am over the age of 18 and understand the obligations of an oath;
2. I am the owner, partner, officer, representative or agent _____ (name of bidder) ("Bidder"), the Bidder that has submitted the attached Bid to Amity Regional School District #5;
3. I am fully informed regarding the preparation and contents of the attached Bid and of all pertinent circumstances regarding such Bid;
4. Such Bid(s) is genuine and is not a collusive or sham Bid;
5. Neither the said Bidder nor any of its officers, partners, owner, agents, representatives, employees or parties in interest, including this affiant, has in any way colluded, conspired, connived, or agreed, directly or indirectly with any other bidder, firm or person to submit a collusive or sham bid in connection with the contract for which the attached Bid has been submitted or to refrain from bidding in connection with such contract, or has in any manner, directly or indirectly, sought by agreement or collusion or communication or conference with any other Bidder, firm or person to fix the price or prices in the attached Bid or of any Bidder, or to fix any overhead, profit or cost element of the Bid price or the Bid price of any other Bidder or to secure through any collusion, conspiracy, connivance or unlawful agreement any advantage with Amity Regional School District #5, its Board of Education, the Amity Regional School District #5 High School Library Media Center Building Committee and/or any person interested in the proposed contract;
6. The price(s) quoted in the attached Bid are fair and proper and are not tainted by collusion, conspiracy, connivance, or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees, or parties in interest; and
7. That no officer, agent, employee or consultant for the Amity Regional School District #5, its Board of Education, the Amity Regional School District #5 High School Library Media Center Building Committee is directly or indirectly interested in the Bid, or in supplies, materials, equipment, work or labor to which it relates, or in any of the profits thereof.

Signed: _____

Name: _____
 (print name)

Title: _____

Subscribed and sworn to before me, the undersigned officer, this ____ day of _____, 202__.

 Notary Public
 My Commission expires:
 Commissioner of the Superior Court

SCHEDULE 2
CORPORATE RESOLUTION

(Must be submitted on corporate letterhead if Bidder is a Corporation)

I _____ (name of Corporation's Secretary), Secretary of _____ (legal name of Corporation), a Corporation duly organized and operating under the laws of _____ (State) do hereby certify that the following is a true, correct and accurate copy of a Resolution duly adopted at a meeting of the Board of Directors of such Corporation, duly convened and held on _____, at which meeting a duly constituted quorum of the Board of Directors was present and voted in favor of such Resolution. I further CERTIFY that such Resolution has not been modified, rescinded, or revoked since the date on which it was enacted, and it is present in full force and effect: _____.

RESOLVED: That the following Officers of this Corporation, or any one of them:

(Name and Title of Officer or Officers)

is empowered to execute and deliver in the name and on the behalf of this Corporation contracts, bids, and other documents to Amity Regional School District #5 and its Board of Education, and are further authorized to affix the Corporate Seal to such documents and to bind the Corporation to such contracts, bids or other documents.

IN WITNESS WHEREOF, the undersigned has affixed his signature and Corporate Seal of the Corporation, this ____ day of _____, 202__.

(Affix Corporate Seal Below)

SIGNATURE OF SECRETARY

(Typed Name of Corporation's Secretary)

SCHEDULE 3
LIST OF REQUIRED BID SUBMISSION DOCUMENTS

The following forms and documents must be completed and submitted as part of each Bid:

1. Completed and Executed Bid Form
2. Completed and executed Non-Collusion Affidavit
3. Completed Corporate Resolution (if Bidder is a corporation)
4. Bid Security: Executed Bid Bond (use Schedule 4) or certified check, cashier's check, Treasurer's check, or money order (letter of credit as bid security to the extent permitted in the Instructions to Bidders)
5. Bidder's Statement of Qualifications
6. Completed and executed Certificate of Compliance with C.G.S Sec. 31-57b (use Schedule 6)
7. Bidder's Contractor Pre-qualification Certificate and the Update (Bid) Statement issued by CTDAS
8. Evidence from the bidder's bonding company evidencing that the bidder, if awarded the Contract, can obtain the required performance bond and labor and materials payment bonds in the full amount of the Base Bid Amount (or evidence that bidder it is a small contractor or a minority business enterprise as defined by CGS Section 4a-60g together with satisfactory evidence of its ability to provide to a letter of credit in lieu of the required performance bond and/or a letter of credit in lieu of the required labor and material payment bond)
9. A complete and realistic proposed construction schedule, including the trades activities, equipment, and materials for the Work consistent with the Owner's anticipated schedule for the Project

**SCHEDULE 4
STANDARD BID BOND FORM**

KNOW ALL MEN BY THESE PRESENTS, That we _____ (hereinafter "Principal"), as principal, and, _____ (hereinafter "Surety"), a corporation organized and existing under the laws of the State of _____, and duly authorized to transact a surety business in the State of Connecticut, as surety, are held and firmly bound unto **Amity Regional School District #5**, as Obligee, in the penal sum of five percent (5%) of the amount of the bid set forth in a proposal hereinafter mentioned, lawful money of the United States of America, for the payment of which, well and truly to be made to the Obligee, the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, That, whereas the Principal has submitted or is about to submit a bid to the Obligee related to a contract for a project for interior renovations, alterations and improvements to the media center at Amity Regional High School located at 25 Newton Road, Woodbridge CT 06525.

NOW, THEREFORE, if the said contract be awarded to the Principal and the Principal shall, within such time as may be specified, enter into the said contract in writing with Amity Regional School District #5, and give the required bonds, with surety acceptable to the Obligee, or if the Principal shall fail to do so, pay to the Obligee the damages which the Obligee may suffer by reason of such failure not exceeding the penalty of this bond, then this obligation shall be void, otherwise to remain in full force and effect.

SIGNED, SEALED AND DELIVERED this ____ day of _____, 2026

Principal: _____ (Name of Contractor)

By _____ (Contractor as Principal)

Name: _____ (Print Name)

Title: _____

Surety: _____ (Name of Surety)

By _____

Name: _____ (Print Name)

Title: _____

SCHEDULE 5
STATEMENT OF QUALIFICATIONS

1. A Letter of Transmittal signed by a principal of the bidder, not to exceed two (2) pages, describing in narrative form the company and the company's qualifications for the Project.
2. Company Overview:
 - a. Name and location, including the office location that will be serving the Owner.
 - b. Number of years the company has been in the business of providing the services or performing the work upon which they are bidding.
 - c. Number of employees and how many of them will be dedicated to the Project.
 - d. Evidence of the company's licensing/authority to do business in the State of Connecticut.
3. Client Base:
 - a. Names and contact information for the five (5) references for whom or which the bidder has provided services or performed work for school districts in the last ten (10) years in connection with projects similar in size and scope to the services and/or work upon which they are bidding. Provide Owner name and telephone number for each Project.
 - b. Provide a description of each of the five (5) projects and the contractor's role in each project.
4. Company Information:
 - a. Name, email, and telephone number of the bidder's contact person.
 - b. A list of the subcontractors that the bidder would engage for the Project
 - c. A list of projects for which the company has provided services in the last five (5) years which projects have similar challenges to the Project and indicate if any claims, disputes, arbitration, or litigation proceedings have occurred on any of these projects. If so, identify if they were between Owner/Contractor or Contractor/Subcontractor and give the status of each.
5. Litigation/Disputes: Provide information concerning any suits filed, judgments entered, or claims made against your company during the last five (5) years with respect to contractual services provided by your company, or any declaration of default or termination for cause against your company with respect to such services.
6. Additional information, not included above, that the company feels may be useful and applicable to this Project and helpful to the Owner's evaluation of the bidder (limit response to two (2) pages).

SCHEDULE 6
CERTIFICATE OF COMPLIANCE WITH CONNECTICUT GENERAL STATUTES SECTION 31-57b

I, the undersigned, hereby certify that all the statements herein contained below have been examined by me and to the best of my knowledge and belief are true and correct.

_____ (bidder name):

1. [] has [] has not: been cited for three (3) or more willful or serious violations of any occupational safety and health act or of any standard, order, or regulation promulgated pursuant to such act, during the three-year period preceding the Bid, provided such violations were cited in accordance with the provisions of any state occupational safety and health act or the Occupational Safety and Health Act of 1970, and not abated within the time fixed by the citation and such citation has not been set aside following appeal to the appropriate agency or court having jurisdiction;
2. [] has [] has not: received one (1) or more criminal convictions related to the injury or death of any employee in the three-year period preceding the Bid.

The list of violations (if applicable) is as follows:

BIDDER NAME: _____

Signed: By _____ Date _____

Its _____ (Title)

Subscribed and sworn to before me, the undersigned officer, on this _____ day of _____, 202__.

Notary Public
Commissioner of the Superior Court
My Commission expires:

BIDDER:

Name_____
Address_____
Contact Person_____
Tel. No._____
Email Address

To: **Amity Regional School District #5**
Attn: Director of Finance
25 Newton Road
Woodbridge, CT 06525

Project: **Amity Regional High School Media Center Interior Alterations**
25 Newton Road
Woodbridge, CT 06525
State Project #205-0046 A
Bid #2026-LMC-HS-1

THIS BID IS SUBMITTED TO: Amity Regional Schol District #5 ("Owner"), 25 Newton Road, Woodbridge CT, 06525, ATTN: Theresa Lumas, Director of Finance.

The undersigned Bidder proposes and agrees, if this Bid is accepted by the Owner, to enter into a contract with Owner in the form included in the Bidding Documents to perform and furnish all work described in and reasonably inferable from the Bidding Documents ("Work") within the times set forth in the Bidding Documents for the above-referenced Project and in accordance with the other terms and conditions of the Bidding Documents, for the sums of money proposed herein.

In preparing this bid, Bidder has carefully examined the Bidding Documents for this Project. Bidder has visited the Project site and is aware of the conditions affecting the Work.

The Bidding Documents upon which this bid is based include, without limitation, Drawings and Project Manual dated November 7, 2025, prepared by Silver/Petrucelli + Associates, Inc., Hamden, Connecticut.

Base Bid:

Entire Project for the Lump Sum Amount of:

\$ _____ Dollars (\$) .00).
written figure

The Bid Amounts proposed above include all labor, materials, equipment, fixtures, systems, supplies, tools, temporary facilities, temporary transportation, supervision, and other services necessary to complete the Work for the Project as described in the Bidding Documents inclusive of, without limitation all charges such as overhead, profit, general conditions, general requirements, insurance and permits.

We will commence performance of the Work on the Project no later than ____ calendar days after receipt of "Notice to Proceed" or signing of Contract, in accordance with Article 3 of the AIA Document A101-2017 included in the Bidding Documents, and will achieve Substantial Completion of the entirety of the Work, or portions thereof, within the Contract Time established by the Contract Documents.

If written notice of the acceptance of this Bid is mailed, telegraphed, or delivered to the undersigned Bidder at the address designated above, within ninety (90) days after the date of Bid Opening, or any time thereafter before this Bid is withdrawn, the undersigned Bidder will, within ten (10) days after the date of mailing, telegraphing, or delivering of the notice, execute and deliver a contract in the form of Contract included in the Bidding Documents as modified by the Owner to incorporate accepted portions of this Bid.

The undersigned acknowledges that he has examined the documents, visited and examined the site as required under "Instructions to Bidders", examined the availability of labor and materials and further agrees to comply with all the requirements as to the conditions of employment and wage rates set forth by the State of Connecticut Department of Labor.

Bidder accepts all terms and conditions of the Invitation to Bid, Instructions to Bidders, and all other Bidding Documents (as defined) in the Instructions to Bidders, including, without limitation those relating to the disposition of Bid Security. This Bid will remain subject to acceptance by the Owner **for ninety (90) days** after the Bids are opened. Bidder will sign and deliver the required number of counterparts of the Contract along with the required payment and performance bonds and other documents required by the Bidding Documents within five (5) days after the Contract is presented by the Owner to the Bidder for signature.

In submitting this Bid, Bidder represents and acknowledges that:

1. Bidder has examined and carefully studied the Bidding Documents and the following Addenda;
2. Bidder's failure to gain familiarity with the Bidding Documents, if any, shall in no way relieve Bidder of responsibility for all aspects of its Bid and the obligations set forth in the Bidding Documents;
3. The Bidder understands the requirements of the Bidding Documents and the scope of Work represented by the Bidding Documents to be performed by or on behalf of a Bidder;
4. Bidder has visited the Project site and become familiar with and is satisfied as to the general, local and site conditions under which the Work is to be performed, that may affect cost, progress, performance and furnishing of the Work and have correlated Bidder's personal observations with the requirements of the Bidding Documents;
5. Bidder is familiar with and agrees to comply with all federal, state, and local Laws and regulations, ordinances, codes and orders that relate to the Project and/or performance of the Work described in the Bidding Documents and/or which may affect cost, progress, performance and furnishing of the Work;
6. Bidder has given the Owner and the Architect written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents and the written resolution thereof by Architect is acceptable to Bidder, and Bidder acknowledges that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work for which this Bid is submitted;
7. Bidder has checked all the amounts set forth in this Bid and the Schedules attached hereto and understands that Owner will not be responsible for any errors or omissions on the part of the Bidder in preparing this Bid;
8. The Base Bid Amount, Allowance Bid Amounts, Unit Price Bid Amounts, and Alternates Bid Amounts, set forth in this Bid Form includes all labor, materials, equipment, fixtures, systems, supplies, tools, temporary facilities, transportation, supervision, and other services necessary to complete the Work for the Project as described in the Bidding Documents, inclusive of, without limitation, overhead, profit, general conditions, general requirements, and insurance and bond costs, all without exception or qualification;
9. Bidder has confirmed and incorporated into its Bid and Bid Amounts the proper prevailing wage rate for its industry;
10. In submitting this Bid, it is understood that the right is reserved by the Owner to reject any or all Bids and waive all technicalities and informalities in connection therewith, including negotiating

with the selected Bidder, all as may be in the best interest of the Owner. It is agreed that this Bid may not be withdrawn for a period of ninety (90) days after the actual date the Bids are opened;

11. Bidder will complete the Work in accordance with the Bidding Documents for the prices set forth above in the Base Bid Amount and Unit Price Bid Amounts, plus the Allowance Bid Amounts and Alternates Bid Amounts for Add Alternate Items agreed to by the Owner on the Contract;
12. Bidder agrees that the Work will be substantially completed and ready for final payment in accordance with the Bidding Documents on or before the dates or within the number of calendar days indicated in the Bidding Documents;
13. Bidder received all the Bidding Documents and following addenda, receipt all of which is hereby acknowledged by the Bidder (list Addenda by Addendum number and date):

Invitation to Bid:	Date: _____	Initials: _____
Instructions to Bidders:	Date: _____	Initials: _____
Project Manual/Specifications:	Date: _____	Initials: _____
Bid Drawings:	Date: _____	Initials: _____
Addendum #: _____	Date: _____	Initials: _____
Addendum #: _____	Date: _____	Initials: _____
Addendum #: _____	Date: _____	Initials: _____
Addendum #: _____	Date: _____	Initials: _____
Addendum #: _____	Date: _____	Initials: _____
Addendum #: _____	Date: _____	Initials: _____

14. The following documents are attached to and made a part of this Bid:

- a. This Bid Form
- b. Completed and executed Non-Collusion Affidavit
- c. Completed Corporate Resolution (if Bidder is a corporation)
- d. (4) Bid Security:
 - ☐ Executed Bid Bond
 - ☐ Certified Check, Cashier's Check, Treasurer's check, or Money Order
 - ☐ Letter of Credit (small contractor or minority business enterprise only)
- e. Completed and executed Certification re: CGS Section 31-57b
- f. Bidder's Contractor Statement of Qualifications
- g. ☐ Evidence of Bidder's Ability To Obtain Performance Bond and Labor and Materials Payment Bond
 - or
 - ☐ Evidence of Bidders Ability to Provide Letters of Credit in Lieu of Performance Bond and Payment Bond (small contractor or minority business enterprise only)
- h. Bidder's DAS Contractor Prequalification Statement
- i. Bidder's Current Update (bid) Statement
- j. A list of Potential Value Engineering Options and their Cost Savings
- k. Three (3) references of relevant and recent similar projects

Communications by the Owner to the Bidder concerning this Bid shall be addressed to the contact person for the Bidder identified on the first page of this Bid Form.

Bidder certifies, under the penalty of false statement, that: (1) the information in this Bid Form and its Bid is true and accurate; (2) that the copy of any Bid Bond submitted with this Bid Form is a true, accurate and unmodified copy of the original bond issued by the Bidder's surety for the Project; (3) that there has been no substantial change in the Bidder's financial position or corporate structure since the Bidder's

most recent prequalification certificate was issued or renewed, other than those changes noted in the update statement; and (4) that the Bid was made without fraud or collusion with any person.

In submitting this Bid, it is understood that the right is reserved by Owner to reject any or all Bids and waive all technicalities and informalities in connection therewith, including negotiating with the selected Bidder or Bidders, all as may be in the best interest of the Owner. It is agreed that this Bid may not be withdrawn for a period of ninety (90) days after the actual date the Bids are opened.

The undersigned declares that the person or persons signing this Bid is/are fully authorized to sign on behalf of the Bidder.

Signed this day ____ of _____, 2026

Signature: _____ Date: _____

Printed Name and Title
of Agent submitting bid: _____

Name of Company: _____

Address: _____

Telephone Number: _____ Fax Number: _____

E-mail: _____

This Bid may be withdrawn prior to the scheduled Bid Opening or any postponement thereof.

AIA® Document A101® – 2017

Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum

AGREEMENT made as of the day of in the year 2026
(In words, indicate day, month and year.)

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

Amity Regional School District #5 (“Owner”)
25 Newton Road
Woodbridge, CT 06525

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

NAME
STREET ADDRESS
CITY, STATE, ZIP

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

Media Center Interior Alterations at Amity Regional High School-Phase 1 of 2
25 Newton Road
Woodbridge, CT 06525 (the “Project”)
State Project Number: 205-0046A

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

Silver/Petrucelli + Associates, Inc.
3190 Whitney Avenue
Hamden, CT 06518

The Owner and Contractor agree as follows.

ADDITIONS AND DELETIONS:
The author of this document may have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added to or deleted from the original AIA text.

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

The parties should complete A101®–2017, Exhibit A, Insurance and Bonds, contemporaneously with this Agreement. AIA Document A201®–2017, General Conditions of the Contract for Construction, is adopted in this document by reference. Do not use with other general conditions unless this document is modified.

ELECTRONIC COPYING of any portion of this AIA® Document to another electronic file is prohibited and constitutes a violation of copyright laws as set forth in the footer of this document.

TABLE OF ARTICLES

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- 8 MISCELLANEOUS PROVISIONS
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ARTICLE 1 THE CONTRACT DOCUMENTS

The Contract Documents consist of this Agreement, AIA Document A201-2017 General Conditions of the Contract for Construction as modified by the Owner and appended hereto (as so modified, referred to hereinafter as the “AIA Document A201-2017”), Drawings, Specifications, Addenda issued prior to execution of this Agreement, other documents listed in this Agreement, and Modifications issued after execution of this Agreement as Contract Documents, all of which form the Contract for Construction between the Owner and the Contractor (the “Contract”) and are as fully a part of the Contract as if attached to this Agreement or repeated herein. The Contract represents the entire and integrated agreement between the Owner and the Contractor relating to the subject matter of this Agreement and supersedes prior negotiations, representations, or agreements, either written or oral, verifiable or alleged. If anything in the other Contract Documents, other than a Modification, is inconsistent with this Agreement, this Agreement shall govern. An enumeration of the Contract Documents, other than a Modification, appears in Article 9. No alteration, modification, or amendment to this Agreement shall be binding upon the parties hereto unless by written instrument, signed by the Owner and the Contractor. This Agreement may be amended only by written instrument signed by both Owner and the Contractor, by written Change Order, or writing as otherwise expressly permitted and provided in this Agreement or the other Contract Documents.

ARTICLE 2 THE WORK OF THIS CONTRACT

§ 2.1 The Contractor shall fully execute the Work described in, reasonably inferable from and as necessary to produce the results intended by, the Contract Documents including, but not limited to, the furnishing of (1) all materials, supplies, equipment, fixtures, tools, implements, and other items and facilities required for, or in connection with, or for inclusion or incorporation into, the Project and (2) all labor, supervision, transportation, utilities, storage and all other services required for or in connection with the Project, except as specifically indicated in the Contract Documents to be the responsibility of others.

§ 2.2 CONTRACTOR'S STANDARD OF CARE, CONDITIONS AND LEGAL REQUIREMENTS

§ 2.2.1 The Contractor shall be responsible for the performance of the Work as an independent contractor and in a good and workmanlike manner (i) consistent with the Contract Documents; (ii) consistent with the instructions, guidance and direction of the Owner and Architect; (iii) consistent with prevailing applicable professional and industry standards; (iv) consistent with sound practices; (v) as expeditiously as is consistent with such professional skill and care and the orderly progress of the Work and with the Contract Documents and the instructions, guidance and direction of the Owner and Architect; and (vi) in a manner that will not exceed the Contract Sum as set forth in the Contract (the standards of this Section 2.2.1 shall be referred to herein as the “Contractor’s Standard of Care”). The Contractor shall exercise the Contractor’s Standard of Care in performing all aspects of the Work. All references in the Contract Documents to the knowledge, inference, reliance, awareness, determination, belief, observation, recognition or discovery of or by the Contractor or reference to any similar term shall include the constructive knowledge, inference, reliance, awareness, determination, belief, observation, recognition attributed to the Contractor (“Constructive Knowledge”). Such Constructive

Knowledge shall include the knowledge, inference, reliance, awareness, determination, belief, observation and recognition the Contractor would have obtained upon the exercise of the Contractor's Standard of Care.

§ 2.2.2 The Contractor shall be responsible for the performance of the Work in accordance with the Contract Documents, and the Conditions (as defined hereinafter), and the Contractor shall obtain and post all necessary permits at the site. The term "Conditions" shall mean and include all "**Legal Requirements**" (as defined in Section 3.7.2 of the AIA Document A201-2017) and/or all guidelines, standards and conditions of funding imposed on the Work and/or Project by the Agencies, as defined hereinafter.

§ 2.2.3 The "Agencies" or an "Agency" mean and include the Connecticut Department of Administrative Services ("DAS"), the Connecticut Commission on Human Rights and Opportunities ("CHRO"), and all other governmental authorities having regulatory or administrative jurisdiction over the Work and/or the Project, and all representatives or designees of DAS, CHRO, and such other governmental authorities.

§ 2.2.4 Legal Requirements and Agency Requirements

§ 2.2.4.1 Without limiting the responsibility of the Contractor under other provisions of the Contract Documents, the Contractor shall comply with and conduct the Work in accordance with all Legal Requirements, which shall include, without limitation, compliance with the requirements of Connecticut Regulation Sections 16a-38k-1 through 9 ("High Performance Building Requirements") to the extent such High Performance Building Requirements are specified in the Contract Documents, including without limitation any waste stream management requirements.

§ 2.2.4.2 Notwithstanding anything to the contrary in this Agreement, the Contractor shall attend such meetings and site-visits, and make such submissions, as are necessary to comply with applicable Legal Requirements.

§ 2.2.4.3.1 Contractor shall provide Change Orders and supporting documents and other required documentation in the form required by DAS and any other Agencies. Contractor shall also maintain records and reports as required by DAS, CHRO, and other Agencies.

§ 2.2.4.3.2 Contractor shall preserve and maintain financial books and records relating to this Contract and the Contractor's performance of the Work for a period of five (5) years after the date of final payment, or for such longer period as may be required by Legal Requirements or the Conditions, and upon request by the Owner or an Agency, shall make such records available to the Owner and/or such Agency as needed to address any audit by an Agency, including without limitation by DAS, CHRO, and/or other Agencies. Such records shall include, without limitation, the Contractor's accounting records including complete documentation to support accounting entries, books, job cost reports, correspondence, instructions, drawings, receipts, subcontracts, Subcontractor bids, Subcontractor or supplier invoices, purchase orders, vouchers, memoranda, written policies and procedures, Change Order files (including documentation covering negotiated settlements), back charge logs and supporting documentation, general ledger entries detailing cash and trade discounts earned, insurance rebates and dividends; electronic or computer data, any other supporting evidence deemed necessary to substantiate charges, and other data relating to this Contract reasonably requested by the Owner or an Agency. Upon request by the Owner and/or any Agency, the Contractor shall deliver to the Owner such records, or any other records or items as are reasonably requested by the Owner in connection with any audit of the Project by the Owner or DAS in connection with any grant or financial assistance from the State of Connecticut for the Project ("DAS Grants"). The Contractor shall comply with all accounting procedures and record retention policies reasonably requested by the Owner and/or required by Legal Requirements or other Conditions, including without limitation DAS's rules and regulations relating to the DAS Grant.

§ 2.2.4.3.3 Upon request of the Owner or the Architect, the Contractor will cooperate with and assist the Owner and Architect with any audit of the Project conducted by the Owner or an Agency at any time after Substantial Completion. Such cooperation shall be at no cost to the Owner unless such cooperation is (1) in connection with an audit other than an audit by CHRO, other Agencies, or the audit to be conducted by DAS for the Project in connection with DAS Grants, (2) provided after the close-out of the Project and demobilization by the Contractor and its Subcontractors, in which case the Contractor shall be entitled to reasonable compensation determined in the manner provided under Section 7.3.3 of AIA Document A201-2017.

§ 2.2.4.4 Any information obtained by the Contractor from the Owner or Architect may not be used, published, distributed, sold or divulged by the Contractor, its Subcontractors, or any Sub-subcontractors for such party's own purposes or for the benefit of any person, firm, corporation or other entity other than the Owner, without the prior written consent of the Owner. Any information obtained by the Contractor or its Subcontractors or any Sub-subcontractors that is designated by the Owner in accordance with applicable Legal Requirements as confidential shall not be disclosed to any other parties without the prior written consent of the Owner.

§ 2.2.4.5 The Contractor shall comply with Legal Requirements applicable to its performance under this Contract, including all equal employment opportunity programs, and other programs as may be required by governmental and quasi-governmental authorities (including without limitation that identified or referenced in Sections 2.2.4.6, 8.8.3, 8.8.4, or 8.8.5 of this Agreement). The Contractor shall be responsible for all fines and penalties assessed against the Owner or the Contractor by any Agency to the extent such fines and penalties arise from the violation of any of the foregoing by the Contractor, any Subcontractor or Sub-subcontractor (as defined in Section 5.1 of the AIA Document A201-2017) or anyone for whom or which any of them is responsible.

§ 2.2.4.6 The Contractor shall be solely responsible for assuring that the procurement and award of Subcontracts for the Work is conducted in a manner consistent with applicable Legal Requirements and the Contract Documents.

§ 2.2.4.7 In procuring any Subcontracts with Subcontractors for performance of any portion of Work, the Contractor shall:

- .1 Coordinate all processes for the solicitation of bids, selection of successful bidders, and award of Subcontracts;
- .2 Incorporate applicable requirements and regulations of the Owner and Town of Woodbridge, as applicable, and of Agencies, as required into bid documents, including without limitation, project labor agreements, compliance with prevailing wage laws and regulations, compliance with local hiring ordinances, compliance CHRO regulations and rules, and compliance with rules and requirements of DAS;
- .3 Develop and prepare bid packages in compliance with all Legal Requirements and the rules and requirements of DAS;
- .4 Solicit and engage Subcontractors with the qualifications and ability to perform the Work and complete the Project;
- .5 Lead and coordinate all pre-bid meetings and Project walk-throughs with the Owner;
- .6 Coordinate with the Owner and the Architect to manage the collection and response to question from prospective bidders;
- .7 Evaluate all bid submissions to determine qualifications and scope and recommend the lowest responsible bidder; and
- .8 Ensure State requirements of CHRO, DAS and/or other State of Connecticut Agencies are satisfied and provide all reporting required site reporting required of Contractor by CHRO, DAS and/or other Agencies.

§ 2.3 THE CONTRACTOR'S PROJECT TEAM

§ 2.3.1 The Contractor accepts the relationship of trust and confidence established by this Agreement and covenants with the Owner to cooperate with the Architect and exercise the Contractor's reasonable skill and judgment in furthering the interests of the Owner. The Contractor agrees to furnish efficient business administration and supervision and to use Contractor's best efforts to furnish, at all times, an adequate supply of skilled workers and materials, and to perform the Work in the most expeditious and economical manner consistent with the Owner's interests.

§ 2.3.2 The Contractor's project team ("Project Team") will consist of, at a minimum, the following:

Project Executive: _____

Project Manager: _____

Superintendent: _____

The Contractor acknowledges that, in entering into this Agreement, the Owner is relying upon the fact that each of the members of the Project Team will continue to perform their services throughout the entirety of the performance of the Work. No change will be made in the membership of the Contractor's Project Team without the Owner's prior written approval, which approval shall not be unreasonably withheld. The Contractor will, upon reasonable notice from the Owner, replace any member of the Project Team whom the Owner reasonably deems unsatisfactory.

ARTICLE 3 DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION

§ 3.1 The date of commencement of the Work shall be:

(Check one of the following boxes.)

☐ The date of this Agreement.

☐ A date set forth in a notice to proceed issued by the Owner.

☐ Established as follows:

(Insert a date or a means to determine the date of commencement of the Work.)

If a date of commencement of the Work is not selected, then the date of commencement shall be the date of this Agreement.

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

§ 3.3 Substantial Completion

§ 3.3.1 Subject to adjustments of the Contract Time as provided in the Contract Documents, the Contractor shall achieve Substantial Completion of the entire Work:

(Check one of the following boxes and complete the necessary information.)

☐ Not later than () calendar days from the date of commencement of the Work.

☐ By the following date:

§ 3.3.2 Subject to adjustments of the Contract Time as provided in the Contract Documents, if portions of the Work are to be completed prior to Substantial Completion of the entire Work, the Contractor shall achieve Substantial Completion of such portions by the following dates:

Portion of Work

Substantial Completion Date

§ 3.3.3 If the Contractor fails to achieve Substantial Completion as provided in this Section 3.3, liquidated damages, if any, shall be assessed as set forth in Section 4.5. **TIME IS OF THE ESSENCE** in the completion of the Work.

ARTICLE 4 CONTRACT SUM

§ 4.1 The Owner shall pay the Contractor the Contract Sum in current funds for the Contractor's performance of the Contract. The Contract Sum shall be **[XXXXXXXX and XX/100 Dollars (\$ X,XXX,XXX.XX)**, subject to additions and deductions as provided in the Contract Documents.

§ 4.2 Alternates

§ 4.2.1 Alternates, if any, included in the Contract Sum:

Item

Price

§ 4.2.2 Subject to the conditions noted below, the following alternates may be accepted by the Owner following execution of this Agreement. Upon acceptance, the Owner shall issue a Modification to this Agreement.

(Insert below each alternate and the conditions that must be met for the Owner to accept the alternate.)

Item	Price	Conditions for Acceptance
§ 4.3 Allowances, if any, included in the Contract Sum: (Identify each allowance.)		
Item	Price	
§ 4.4 Unit prices applicable to the Work, if any, are set forth below (the "Unit Prices"). Unit Prices shall be valid for the life of the Project and are inclusive of all costs associated with the complete performance, furnishing, and installation of the portion of the Work subject to Unit Prices including, without limitation, labor, materials, equipment, machinery, services, engineering, transportation, taxes and insurance as well as overhead and profit. Unit Prices shall be applicable to both additions to and deductions from the Work: (Identify the item and state the unit price and quantity limitations, if any, to which the unit price will be applicable.)		
Item	Units and Limitations	Price per Unit Added (\$0.00)
		Price per Unit Deducted (\$0.00)
§ 4.5 Liquidated damages, if any: Five Hundred and 00/100 Dollars (\$500.00) per day. It is acknowledged that the Contractor's failure to achieve Substantial Completion of the entire Work within the Contract Time established in Section 3.3.1 of this Agreement will cause the Owner to incur substantial economic damages and losses of types and in amounts which are impossible to compute and ascertain with certainty as a basis for recovery by the Owner of actual damages, and that liquidated damages represent a fair, reasonable and appropriate estimate thereof. Accordingly, in lieu of actual damages for such delay, the Contractor agrees that liquidated damages may be assessed and recovered by the Owner as against the Contractor and its Surety in the event of delayed completion of the Work, without the Owner being required to present any evidence of the amount or character of actual damages sustained by reason thereof. Therefore, the Contractor shall be liable to the Owner for payment of liquidated damages in the amount of Five Hundred and 00/100 Dollars (\$500.00) for each day that Substantial Completion of the entire Work is delayed beyond the Contract Time established in Section 3.3.1 of this Agreement for the achievement of Substantial Completion of the entirety of the Work, as the Contract Time may be adjusted for time extensions granted by the Owner through a Change Order in accordance with the terms and conditions of the Contract Documents. Such liquidated damages are intended to represent estimated actual damages and are not intended as a penalty. The Contractor shall pay liquidated damages assessed by the Owner, to the Owner, without prejudice to or limiting Owner's right to terminate this Agreement as provided elsewhere in this Agreement. The collection of liquidated damages by the Owner under this Section 4.5 shall be in addition to, and not in lieu of, the Owner's right to recover from the Contractor the Owner's increased costs to complete the Project arising from the Contractor's delay. Further, such liquidated damages shall in no way limit the Owner's other rights under this Agreement or the Owner's entitlement to damages for any other injury, damage or loss, other than for delay, for which Contractor may be responsible.		
§ 4.6 Other: (Insert provisions for bonus or other incentives, if any, that might result in a change to the Contract Sum.) None.		
§ 4.6.1 The Contractor represents and warrants that the Drawings and Specifications and other materials and information furnished to the Contractor are sufficiently detailed to enable the Contractor to firmly establish the Contract Sum, subject to clarifications and assumptions (if any) expressly herein set forth.		

ARTICLE 5 PAYMENTS

§ 5.1 Progress Payments

§ 5.1.1 Based upon Applications for Payment submitted to the Architect and Owner by the Contractor and Certificates for Payment issued by the Architect, the Owner shall, upon its determination that the Work or a portion of the Work, as applicable, has been completed in a manner consistent with the Contract Documents, make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.

§ 5.1.2 The period covered by each Application for Payment shall be one calendar month ending on the last day of the month.

§ 5.1.3 Each month on or before the fifth (5th) business day of such month, the Contractor shall submit to the Architect and the Owner a final version of the Contractor's Application for Payment along with all required Supporting Documentation (as defined in and in accordance with Section 9.3 of AIA Document A201-2017) for all Work properly performed in the prior month. The Owner shall, subject to the provisions of Section 9.6.8 of AIA Document A201-2017, make payment to the Contractor of the amount certified by the Architect to be due and payable to the Contractor under such Application for Payment not later than thirty (30) days after the date the Architect receives the final version of the Application for Payment and all required Supporting Documentation.

§ 5.1.3.1 Commencing with the second Application for Payment, and continuing with each Application for Payment submitted thereafter, Supporting Documentation shall include, without limitation, a properly executed release and waiver of claims and mechanic's liens from the Contractor and each Subcontractor and material supplier whose Work was included on the previous Application for Payment for which payment by Owner was made to the Contractor. In addition to the foregoing, commencing with the first Application for Payment and continuing with each Application for Payment submitted thereafter, the Contractor shall provide a properly executed conditional release and waiver of claims and mechanic's liens, in form acceptable to the Owner, from the Contractor and each Subcontractor and material or equipment supplier whose Work is included on the Application for Payment subject only to receipt of payment under such Application for Payment.

§ 5.1.4 Each Application for Payment shall be based on the most recent schedule of values submitted by the Contractor in accordance with the Contract Documents and approved by the Owner and the Architect pursuant to Section 9.2 of the AIA Document A201-2017 (the "Schedule of Values"). The Schedule of Values shall allocate the entire Contract Sum among the various portions of the Work. The Schedule of Values shall be prepared in such form, and supported by such data to substantiate its accuracy, as the Architect may require. This Schedule of Values shall be used as a basis for reviewing the Contractor's Applications for Payment.

§ 5.1.5 Applications for Payment shall show the percentage of completion of each portion of the Work as of the end of the period covered by the Application for Payment. Each Application for Payment shall include a statement showing the status of all pending change orders, other pending change directives and approved changes to the Contract. Such statement shall identify the pending change orders and other pending change directives, and shall include the date such change orders and directives were initiated, the costs associated with their performance, and a description of any Work completed.

§ 5.1.6 In accordance with AIA Document A201-2017, and subject to other provisions of the Contract Documents, the amount of each progress payment shall be computed as follows:

§ 5.1.6.1 The amount of each progress payment shall first include:

- .1 That portion of the Contract Sum properly allocable to completed Work based on the Schedule of Values;
- .2 That portion of the Contract Sum properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the completed construction, or, if approved in advance by the Owner, suitably stored off the site at a location agreed upon in writing; and
- .3 That portion of Construction Change Directives that the Architect determines, in the Architect's professional judgment, to be reasonably justified.

§ 5.1.6.2 The amount of each progress payment shall then be reduced by:

- .1 The aggregate of any amounts previously paid by the Owner;
- .2 The amount, if any, for Work that remains uncorrected and for which the Architect has previously withheld a Certificate for Payment as provided in Article 9 of AIA Document A201-2017;

- .3 Any amount for which the Contractor does not intend to pay a Subcontractor or material supplier, unless the Work has been performed by others the Contractor intends to pay;
- .4 For Work performed or defects discovered since the last payment application, any amount for which the Architect may withhold payment, or nullify a Certificate of Payment in whole or in part, as provided in Article 9 of AIA Document A201–2017;
- .5 Retainage withheld pursuant to Section 5.1.7;
- .6 In addition to retainage withheld pursuant to Section 5.1.7, unless the Contractor is exempted by CHRO from the requirements of, or compliance with, Connecticut General Statutes Section 46a-68e, the Owner shall withhold from each progress payment to the Contractor an amount equal to two percent (2%) of the amount otherwise due (the “CHRO Holdback”), until such time as the Contractor has filed with CHRO and caused all Subcontractors to file with CHRO all compliance reports required by CHRO pursuant to General Statutes Section 46a-68e, and such reports have been approved by the executive director of CHRO or the executive director's designee or deemed by CHRO deficient without consequence.
- .7 In addition to retainage withheld pursuant to Section 5.1.7, any additional amounts required by law to be withheld or retained by the Owner due to the Contractor's failure to comply with its obligations under Connecticut General Statutes Sections 4a-60, 4a-60g, 4a-60h, or Sections 46a-68c, 46a-68d, 46a-68e and/or 46a-68f, inclusive, or as required by an order of CHRO made pursuant to Connecticut General Statutes Section 46a-56.

§ 5.1.7 Retainage

§ 5.1.7.1 For each progress payment, the Owner may withhold the following amount, as retainage, from the payment otherwise due:

(Insert a percentage or amount to be withheld as retainage from each Application for Payment. The amount of retainage may be limited by governing law.)

Five percent (5%)

§ 5.1.7.1.1 The following items are not subject to retainage:

(Insert any items not subject to the withholding of retainage, such as general conditions, insurance, etc.)

Not applicable

§ 5.1.7.2 Intentionally omitted.

(If the retainage established in Section 5.1.7.1 is to be modified prior to Substantial Completion of the entire Work, including modifications for Substantial Completion of portions of the Work as provided in Section 3.3.2, insert provisions for such modifications.)

§ 5.1.7.3 Upon Substantial Completion of the Work and such acceptance, and consent of surety if any, the Owner may, in its sole and absolute discretion, release and make payment of all or a portion of retainage as applicable to the Work that is complete in accordance with the Contract Documents. The Owner shall not, however, be obligated to release any portion of retainage held by the Owner until the Contractor has fulfilled all of its obligations under, and in accordance with, the Contract Documents.

(Insert any other conditions for release of retainage upon Substantial Completion.)

§ 5.1.8 If final completion of the Work is materially delayed through no fault of the Contractor, any Subcontractor, Sub-subcontractor or any other person or entity for whom or which any of them is responsible, the Owner shall pay the Contractor any additional amounts to the extent required under Article 9 of AIA Document A201–2017.

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

§ 5.1.10 The Contractor shall use payments made under this Agreement solely for the purpose of paying for the

performance of the Work pursuant to the Contract Documents. Contractor shall pay for all labor and services performed and materials, equipment and machinery supplied by others in connection with the performance of the Work in accordance with the Contract Documents and as required by applicable Legal Requirements.

§ 5.1.11 The Contractor shall pay any amounts due a Subcontractor or supplier or other person or entity providing or performing Work, whether for labor or services performed or materials, equipment or machinery furnished, not later than fifteen (15) days after the date the Contractor receives payment from the Owner which encompasses such labor or services performed or materials, equipment or machinery furnished by such Subcontractor or supplier or other person or entity providing or performing Work. Payment shall be the amount to which the Subcontractor or supplier or other person or entity is entitled, reflecting percentages actually retained by the Owner from payments to the Contractor on account of the portion of the Work performed by the Subcontractor or supplier or other person or entity.

The Contractor shall, by appropriate agreement with each Subcontractor or supplier or other person or entity providing or performing Work for the Contractor, require each person or entity providing or performing such Work to make payments to subconsultants or Sub-subcontractors in a similar manner. The Contractor shall include in each subcontract entered into by the Contractor with any Subcontractor or supplier or other person or entity in connection with the Work, a provision requiring the Subcontractor or supplier or other person or entity to pay any amounts due any of their Sub-subcontractors or suppliers, whether for labor or services performed or materials, equipment or machinery furnished, within thirty (30) days after such Subcontractor or supplier or other person or entity receives a payment from the Contractor which encompasses labor or services performed, or materials, equipment or machinery furnished by such sub-subcontractor or supplier.

§ 5.1.11 Retainage withheld by the Contractor on amounts due any Subcontractor or supplier or other person or entity performing or providing the Work shall not exceed five percent (5%) of such amount due.

§ 5.2 Final Payment

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

- .1 the Contractor has fully performed the Work and all of its obligations under the Contract Documents except for the Contractor's responsibility to correct Work as provided in Article 12 of AIA Document A201-2017, and to satisfy other requirements, if any, which extend beyond final payment;
- .2 the Contractor has submitted a final Application for Payment together with all required Supporting Documentation; and
- .3 a final Certificate for Payment has been issued by the Architect in accordance with Section 9.10 of AIA Document A201-2017.

§ 5.2.2 The Owner's final payment to the Contractor, including retainage withheld pursuant to Section 5.1.7, shall be made no later than ninety (90) days after the Owner's acceptance of all Work required by the Contract Document and issuance of the Architect's final Certificate for Payment. The Architect's final Certificate for Payment shall not be issued unless and until all required Supporting Documentation required by the Contract Documents, and such additional information as is reasonably requested by the Owner, have been submitted to the Architect by the Contractor.

§ 5.2.2.1 Notwithstanding anything to the contrary set forth herein or in any other Contract Documents, Owner shall not be required to make final payment until the Contractor has submitted all documentation required by the Contract Documents to the Owner and the Owner has accepted the same, including without limitation, all warranties and guarantees associated with the Work and "as built" surveys in form acceptable to the Owner.

§ 5.2.2.2 In the discretion of the Owner, the Owner may make final payment to the Contractor by joint checks made payable in each case to the Contractor and the appropriate Subcontractor or supplier. The Contractor acknowledges and agrees that such payment by joint check shall constitute payment by Owner to the Contractor.

§ 5.3 Interest

Payments due and unpaid under the Contract shall bear interest only to the extent required by Connecticut law and, if so required, at the minimum required rate.

§ 5.4 Any provision herein to the contrary notwithstanding, the Owner shall not be obligated to make payment to the Contractor hereunder to the extent any one or more of the following conditions exist:

- 1 The Contractor is in default of any of its obligations hereunder or otherwise is in default under any of the Contract Documents;
- 2 Any part of such payment is attributable to Work which the Owner or the Architect determines that, because of the fault or neglect of the Contractor, is defective or not performed in accordance with the Contract Documents; provided, however, such payment shall be made as to the part thereof attributable to the Work which is performed in accordance with the Contract Documents and is not otherwise defective; or
- 3 The Contractor has failed to make payments properly to Subcontractors or for material or labor used in the Work for which the Owner has made payment to the Contractor.

ARTICLE 6 DISPUTE RESOLUTION

§ 6.1 Initial Decision Maker

The Architect will serve as the Initial Decision Maker pursuant to Article 15 of AIA Document A201–2017, unless the parties appoint below another individual, not a party to this Agreement, to serve as the Initial Decision Maker.

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

§ 6.2 Binding Dispute Resolution

For any Claim subject to, but not resolved by, mediation pursuant to Article 15 of AIA Document A201–2017, the method of binding dispute resolution shall be as follows:

(Check the appropriate box.)

☐ Arbitration pursuant to Section 15.4 of AIA Document A201–2017

☒ Litigation in a court of competent jurisdiction

☐ Other *(Specify)*

§ 6.3 Choice of Law/Forum Selection/Waiver of Jury Trial

This Agreement, the Contract, and the Contract Documents shall be governed by and construed in accordance with the laws of the State of Connecticut, without regard to its choice of law or conflict of law principles which would result in the application of the laws of any jurisdiction other than the State of Connecticut and applicable federal law of the United States.

The Owner and the Contractor expressly agree and acknowledge that any action or legal proceeding by the Owner or Contractor against the other, which action or legal proceeding arises from or relates to the Contract, shall be commenced in the Superior Court of the State of Connecticut, Judicial District of Waterbury and maintained therein or in the Complex Litigation Docket at the Judicial District of Waterbury or Judicial District of Hartford, which shall be the exclusive forum and venue for any such action or legal proceeding.

THE CONTRACTOR HEREBY WAIVES THE RIGHT TO TRIAL BY JURY IN ANY ACTION OR LEGAL PROCEEDING ARISING FROM OR RELATING TO THE CONTRACT, AND AS TO ANY AND ALL CLAIMS, DISPUTES, AND/OR CAUSES OF ACTION AGAINST OR WITH OWNER WHICH ARISE OUT OF, OR ARE IN CONNECTION WITH, THE CONTRACT AND/OR THE PROJECT.

ARTICLE 7 TERMINATION OR SUSPENSION

§ 7.1 The Contract may be terminated by the Owner or the Contractor as provided in Article 14 of AIA Document A201–2017.

§ 7.1.1 If the Contract is terminated for the Owner's convenience in accordance with Article 14 of AIA Document A201-2017, then the Owner shall pay the Contractor as provided in Article 14 of AIA Document A201-2017.

§ 7.2 The Work may be suspended by the Owner as provided in Article 14 of AIA Document A201-2017.

ARTICLE 8 MISCELLANEOUS PROVISIONS

§ 8.1 Where reference is made in this Agreement to a provision of AIA Document A201-2017 or another Contract Document, the reference refers to that provision as amended or supplemented by other provisions of the Contract Documents.

§ 8.2 The Owner's representative:

(Name, address, email address, and other information)

NAME/TITLE

Amity Regional School District #5 Offices

25 Newton Road

Woodbridge, CT 06525

Email: @amityregion5.org

Tel:

§ 8.3 The Contractor's representative:

(Name, address, email address, and other information)

NAME/TITLE

STREET ADDRESS

CITY, STATE, ZIP

Email:

Tel:

§ 8.4 The Contractor's representative shall not be changed without at least ten (10) days' prior notice to the Owner and Architect.

§ 8.5 The Architect's representative:

NAME/TITLE

STREET ADDRESS

CITY, STATE, ZIP

Email:

Tel:

§ 8.6 Insurance

§ 8.6.1 The Contractor shall purchase and maintain insurance as required and set forth in **Exhibit A** attached hereto, and elsewhere in the Contract Documents.

§ 8.6.2 The Contractor shall provide surety bonds as set forth in Section 8.6.3 and elsewhere in the Contract Documents.

§ 8.6.3.1 Contractor Performance Bond and Payment Bond

Except as set forth in subsection 8.6.3.2, the Contractor shall provide surety bonds, from a company or companies lawfully authorized to issue surety bonds in the State of Connecticut with an AM Best rating of no less than A-, IX or who are otherwise acceptable to the Owner, as follows:

1. a Payment Bond in the amount of 100% of the Contract Sum, for the protection of persons supplying labor or materials in the prosecution of the Work for the use of each such person; and
2. a Performance Bond in the amount of 100% of the Contract Sum.

Payment and Performance Bonds shall be AIA Document A312-2010™, Payment Bond and Performance Bond, or contain

provisions identical to AIA Document A312-2010™.

§ 8.6.3.2 Letter of Credit In Lieu of Surety Bonds

If the Contractor is a small contractor or a minority business enterprise as defined by Connecticut General Statutes Section 4a-60g, the Contractor may:

- .1 in lieu of providing a Payment Bond in accordance with Section 8.6.3.1.1, provide a letter of credit in an amount equal to twenty-five percent (25%) if the Contract Sum; and
- .2 in lieu of providing a Performance Bond in accordance with Section 8.6.3.1.2, provide a provide a letter of credit in an amount equal to twenty-five percent (25%) if the Contract Sum.

§ 8.6.3.3 Subcontractor Payment Bonds

The Contractor shall obtain from each Subcontractor with whom the Contractor enters into a Subcontract having a Subcontract value or price of One Hundred Thousand Dollars (\$100,000.00) or more, a Payment Bond for the protection of persons supplying labor or materials in the prosecution of the Work for the use of each such person, from a company or companies lawfully authorized to issue surety bonds in the State of Connecticut with an AM Best rating of no less than A-VII or who are otherwise acceptable to the Owner and the Contractor, which bond shall be in the amount of 100% of the amount of such Subcontract. Such Payment Bond shall be AIA Document A312-2010™, Payment Bond or contain provisions identical thereto.

§ 8.7 Notice in electronic format, pursuant to Article 1 of AIA Document A201–2017, may be given in accordance with a building information modeling exhibit, if completed, or as otherwise set forth below:

(If other than in accordance with a building information modeling exhibit, insert requirements for delivering notice in electronic format such as name, title, and email address of the recipient and whether and how the system will be required to generate a read receipt for the transmission.)

Notice pursuant to Section 1.6.1 of the AIA Document A201-2017 may be delivered by electronic mail to the email address for the recipient's representative identified in Sections 8.2, 8.3, and 8.5 above, as applicable. The subject line of the email shall include the address of the Project and be electronically flagged as "urgent."

§ 8.8 Other provisions:

§ 8.8.1 The Contractor hereby represents and warrants (in addition to other representations and warranties contained in the Contract Documents), as an inducement to the Owner to enter into the Contract, which representations and warranties shall survive the final completion of the Work:

- .1 that it is financially solvent, able to pay its debts as they mature and possessed of sufficient working capital to complete the Work and perform its obligations under the Contract Documents;
- .2 that it, through its Subcontractors or otherwise, is able to furnish the tools, materials, supplies, equipment and labor required to complete the Work and perform its obligations hereunder in a timely manner and has sufficient experience and competence to do so;
- .3 the Contractor is authorized to do business in the State of Connecticut and is properly licensed by all necessary governmental authorities having jurisdiction over the Contractor and the Project; and
- .4 the Contractor has visited the site of the Project and become familiar with the condition of the site and the Contract Documents, and knows of no reason why the Work cannot be performed as set forth in, and in the timeframe required by, the Contract Documents.

§ 8.8.2.1 Execution in Counterparts. This Agreement and any of the other Contract Documents requiring signature of the parties may be signed in two or more separate counterparts, each of which shall be treated as an original but which, when taken together, shall constitute one and the same instrument, provided such instrument not be effective until each party has executed and exchanged at least one counterpart. Exchange by fax, or by email attaching an executed copy of this Agreement or other Design-Build Document so-executed, and/or in Adobe Portable Document Format (".pdf"), will be considered a valid and binding obligation of the executing party.

§ 8.8.2.2 Electronic Signatures. Each party agrees that the parties may, to the extent that it is permissible under applicable law, sign this Agreement or other Contract Documents requiring signature of the parties, by way of electronic signature (such as DocuSign, AdobeSign, etc.), and that that method of signature is as conclusive of each party's intent to be bound by this Agreement or other Contract Documents so-executed, as if it had been signed by each party's manual "wet ink"

signature.

§ 8.8.3 Nondiscrimination Affirmation.

The Contractor affirms that, by signing this Agreement, the Contractor certifies (i) that the Contractor has reviewed Connecticut General Statutes Sections 4a-60 (portions of which are set forth in Section 3.1.7 of AIA Document A201-2017), (ii) that the Contractor understands its obligations pursuant to Section 3.1.7 of AIA Document A201-2017 and Connecticut General Statutes Section 4a-60, and (iii) that the Contractor will maintain a policy for the duration of the Contract to assure that the Contract will be performed in compliance with the nondiscrimination requirements set forth in Section 3.1.7 of AIA Document A201-2017 and Connecticut General Statutes Section 4a-60(b).

§ 8.8.4 Utilization of Small Business and Minority Business Enterprises

This Contract and the Project are subject to compliance with Connecticut General Statutes Section 4a-60g and State of Connecticut law requirements for spending allocation goals ("SAGs") established by CHRO for the award of subcontracts to small contractor and/or minority business enterprises. Connecticut law requires a minimum SAG of twenty-five (25%) percent of the total state-funded portion of the Contract for award to Subcontractors holding current certification from the Connecticut Department of Administrative Services under the provisions of Connecticut General Statutes Section 4a-60g as Small Business Enterprises ("SBE"), and a minimum of 6.25% of the total state-funded portion of the Contract for award to Subcontractors holding current certification from the Connecticut Department of Administrative Services under the provisions of Connecticut General Statutes Section 4a-60g as Minority-, Women-, and/or Disabled-owned businesses ("MBEs"). The Contractor must demonstrate good faith effort to meet the SAGs for the Project.

§ 8.8.4.1 The Contractor shall perform under this Contract in accordance with Connecticut General Statutes Sections 4a-60, 4a-60g and 4a-60h in the procurement of Subcontractors to perform the Work.

§ 8.8.4.2 Determination of the Contractor's good faith efforts shall include, but shall not be limited to, the following factors: The Contractor's employment and subcontracting policies, patterns and practices, including without limitation the Contractor's utilization of reasonable steps and best suggested practices established by CHRO to achieve SAGs; affirmative advertising, recruitment and training; technical assistance activities and such other reasonable activities or efforts as CHRO may prescribe that are designed to promote the participation of SBEs and MBEs in public works projects.

§ 8.8.4.3 The Contractor shall develop and maintain adequate documentation, in a manner prescribed by CHRO, of its good faith efforts.

§ 8.8.5 Equal Employment Opportunity. The Contractor agrees and warrants that in the performance of the Contract, it will not discriminate or permit discrimination against any person, or group of persons, on the grounds of race, color, religious creed, age, marital status, national origin, sex, sexual orientation, physical disability, including but not limited to blindness, unless it is shown by the Contractor that such disability prevents performance of the Work involved, in any manner prohibited by the laws of the United States or the State of Connecticut. The Contractor shall provide to the Owner such information that Owner requests concerning the employment practices and procedures of the Contractor as relates to the provisions of this Section 8.8.5. For the purpose of the aforesaid provision, performance of the Contract shall include, but not be limited to, the following: advertising, recruitment, layoff, termination, rates of pay or other forms of compensation, conditions or privileges of employment, selection for apprenticeship, selection for retention of subcontractors, or in the procurement of materials, equipment or services.

§ 8.8.5.1 The Contractor shall hereinafter post on the Project site, in conspicuous places available for employees and applicants for employment, notices setting forth its non-discrimination requirements.

§ 8.8.5.2 In all contracts between the Contractor and any Subcontractor or supplier, either for Work to be performed under a Subcontract or the procurement of materials, equipment or services, each consultant, Subcontractor or supplier shall be notified in writing by the Contractor of the Contractor's obligations under this Contract relating to non-discrimination, and each, by their contracting agent, shall agree to and be bound by the such terms of this Contract.

§ 8.8.5.3 Nothing in this Section 8.8.5 shall be deemed to relieve the Contractor from compliance with all applicable federal, state and municipal law concerning equal employment opportunity, non-discrimination, good faith efforts to award subcontracts to small contractors and minority business enterprises, and related subjects during the term of the Contract.

§ 8.8.6 Compliance with Connecticut General Statutes Section 31-52a. In the employment of labor to perform the Work specified under the Contract Documents, preference shall be given by the Contractor to residents of the State of Connecticut, who are, and continuously for at least six (6) months prior to the date of this Agreement have been, residents of the State of Connecticut, and if no such person is available then to residents of other states.

§ 8.8.7 Prevailing Wage. The Contractor shall comply with, and cause all Subcontractors and Sub-subcontractors providing labor for performance of the Work and/or off-site custom fabrication for the Work to comply with Connecticut General Statutes Section 31-53. The wages paid on an hourly basis to any person performing the work of any mechanic, laborer or worker on the Work herein contracted to be done and the amount of payment or contribution paid or payable on behalf of each such person to any employee welfare fund, as defined in subsection (i) of Connecticut General Statutes Section 31-53, shall be at a rate equal to the rate customary or prevailing for the same work in the same trade or occupation in the Town of Woodbridge. Any contractor who is not obligated by agreement to make payment or contribution on behalf of such persons to any such employee welfare fund shall pay to each mechanic, laborer or worker as part of such person's wages the amount of payment or contribution for such person's classification on each pay day. For purposes of this Section 8.8.7, "off-site custom fabrication" means the fabrication of mechanical systems that are fabricated at a site located within the State of Connecticut other than the location of the Project, but are fabricated specifically for the Project, including plumbing systems, heating systems, cooling systems, pipefitting systems, ventilation systems or exhaust duct systems; provided, "off-site custom fabrication" does not include components or materials that are stock shelf items or readily available.

§ 8.9 Successors and Assigns

The Owner and the Contractor, respectively, bind themselves, their partners, successors, assigns, and legal representatives to the covenants, agreements, and obligations contained in the Contract Documents. Neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract. All terms and provisions of this Agreement shall be binding upon, inure to the benefit of, and be enforceable by, the Owner and the Contractor, and their respective administrators, legal representatives, directors, officers, employees, agents, successors and permitted assigns.

§ 8.10 Capitalization

Terms capitalized in this Agreement and the other Contract Documents include those that are (1) defined within the Contract Documents, (2) the titles of numbered articles, or (3) the titles of other AIA Contract Documents.

§ 8.11 Interpretation

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

§ 8.11.2 The invalidity of any provision of any of the Contract Documents shall not invalidate this Agreement or its remaining provisions, or any other provision of any other of the Contract Documents. If it is determined by a court of competent jurisdiction or arbitrator(s) that any provision of this Agreement or any of the other Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be deemed revised to the extent necessary to make that provision legal, and/or valid and enforceable. In such case the Contract shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing this Agreement, and the invalidity of any part or provision of the Contract Documents shall not impair or affect in any manner the validity, enforceability or effect of the remaining parts and provisions of the Contract Documents.

§ 8.12 Headings. Section headings in the Contract Documents are intended solely for convenience or reference, and they shall be given no effect in the construction or interpretation of the Contract.

§ 8.13 Rights and Remedies. The rights and remedies of the Owner that are provided for in this Agreement, and all other rights and remedies that are available to the Owner at law or in equity, are, to the extent permitted by applicable law, cumulative and are not exclusive of any other right or remedy now or hereafter available at law or in equity to the Owner. Neither the Owner's assertion of a right nor employment of a remedy shall preclude the Owner from concurrently asserting any other right or the employment of any other remedy.

§ 8.14 No action or failure to act by the Owner to enforce any provision of the Contract shall constitute a waiver of a right

or duty afforded the Owner under the Contract or constitute approval of or acquiescence of the Owner in a breach by the Contractor hereunder, except as the Owner may specifically agree in writing, nor shall such action or failure to act by the Owner constitute a waiver of any such provision or a limitation upon of the right of Owner to subsequently enforce strict compliance with all provisions, terms and conditions of the Contract.

§ 8.15 Exhibits and Conflicts. To the extent that there is any conflict or inconsistency between the provisions of this Agreement and the provisions of any other Contract Document, the provisions of this Agreement shall control, unless the provisions of the concerned other Contract Document explicitly acknowledge such a conflict and explicitly state that it is the parties' intent that such provisions of the other Contract Document control with respect to the involved topic.

§ 8.16 Entire Agreement/Modifications. There are no oral agreements between the Owner and the Contractor affecting this Agreement, and this Agreement sets forth all of the covenants and agreements between the Owner and the Contractor with regard to the performance of the Work and the subject-matter of this Agreement. This Agreement, in all of its parts, represents the entire and integrated agreement between the parties hereto relating to the subject-matter of this Agreement and the Project, and supersedes and replaces all prior negotiations, representations, and agreements, oral or written, verifiable or alleged. This Agreement may be modified only by written amendment, signed by both of the Owner and the Contractor, or by written Change Order or writing as otherwise expressly permitted and provided in this Agreement. No alteration, modification, or amendment to this Agreement shall be binding upon the Parties hereto unless by written instrument.

ARTICLE 9 ENUMERATION OF CONTRACT DOCUMENTS

§ 9.1 This Agreement is comprised of the following documents:

- .1 This Agreement
- .2 **Exhibit A** - Insurance Requirements
- .3 AIA Document A201-2017, as modified by the Owner
- .4 **Exhibit B** - Drawings
 - .1 Amity Regional HS Media Center Interior Alterations, 25 Newton Road, Woodbridge, CT Phase 1 of 2, 11/07/2025, State Project #205-0046A, prepared for Amity Regional School District #5 by Silver/Petrucelli + Associates, Inc.
- .5 **Exhibit C** - Specifications
 - .1 Amity Regional HS Media Center Interior Alterations, 25 Newton Road, Woodbridge, CT Phase 1 of 2, 11/07/2025, State Project #205-0046A, prepared for Amity Regional School District #5 by Silver/Petrucelli + Associates, Inc.
- .6 Addenda, if any:

Number	Date	Pages

Portions of Addenda relating to bidding or proposal requirements are not part of the Contract Documents unless the bidding or proposal requirements are also enumerated in this Article 9.

- .7 Other documents, if any, listed below:
(List here any additional documents that are intended to form part of the Contract Documents. AIA Document A201™–2017 provides that the advertisement or invitation to bid, Instructions to Bidders, sample forms, the Contractor’s bid or proposal, portions of Addenda relating to bidding or proposal requirements, and other information furnished by the Owner in anticipation of receiving bids or proposals, are not part of the Contract Documents unless enumerated in this Agreement. Any such documents should be listed here only if intended to be part of the Contract Documents.)

- .1 **Exhibit D** -- Contractor’s Completed Bid Form, dated [MONTH, DAY, YEAR]
- .2 **Exhibit E** – Connecticut Department of Labor Wage Rates System Annual Adjusted July 1st Rates, July 1, 2025
- .3 **Exhibit F** - Addenda No. 2 to Amity RSD5 Invitation to Bid dated [MONTH, DAY, YEAR]

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

OWNER (Signature)

Jennifer Byars, Superintendent
Amity Regional School District #5
(Printed name and title)

CONTRACTOR (Signature)

NAME/TITLE
(Printed name and title)



EXHIBIT A
to A101-2017 Agreement dated _____, 2026 between
Amity Regional School District #5 as Owner and _____ as Contractor

INSURANCE REQUIREMENTS

I. Contractor's Insurance Requirements

Before commencement of construction of the Work at the Project site, the Contractor shall purchase and maintain the following types and limits of insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the State of Connecticut. The Contractor shall maintain the required insurance until the expiration of the period for correction of Work as set forth in Section 12.2.2 of the AIA A201-General Conditions contained in the Bidding Documents, except that the Contractor shall maintain its Commercial General Liability Policy for seven (7) years after the date of Substantial Completion of the Work.

Insurance requirements set forth in this Exhibit A are independent of, and in addition to, the Contractor's liability under the Contract Documents. Nothing in the Contract Documents shall be deemed to limit Contractor's liability under the Contract Documents to the limits of coverage of insurance required hereunder. The Contractor shall be solely responsible for payment of all deductible or retention amounts pertaining to any insurance required hereunder. The limit and coverages set forth herein are the minimum requirements under the Contract Documents. The inclusion of these minimum requirements shall not be interpreted to restrict the rights of the additional insureds to the stated minimum coverage amounts in the event the Contractor maintains coverage at higher limits.

A. Commercial General Liability

Commercial General Liability insurance for the Project written on an occurrence form with policy limits of not less than One Million Dollars (\$1,000,000) each occurrence, Two Million Dollars (\$2,000,000) general aggregate, and Two Million Dollars (\$2,000,000) aggregate for products-completed operations hazard, providing coverage for claims including

- (1) damages because of bodily injury, sickness or disease, including occupational sickness or disease, and death of any person;
- (2) personal injury and advertising injury;
- (3) damages because of physical damage to or destruction of tangible property, including the loss of use of such property;
- (4) bodily injury or property damage arising out of completed operations;
- (5) the Contractor's indemnity obligations under Section 3.18 of the AIA A201-General Conditions contained in the Bidding Documents; and
- (6) electronic data liability (under endorsement ISO CG 04 37 or its equivalent).

The Contractor's Commercial General Liability policy shall not contain an exclusion or restriction of coverage for the following:

- (1) Claims by one insured against another insured, if the exclusion or restriction is based solely on the fact that the claimant is an insured, and there would otherwise be coverage for the claim;
- (2) Claims for property damage to the Contractor's Work arising out of the products-completed operations hazard where the damaged Work or the Work out of which the damage arises was performed by a Subcontractor;
- (3) Claims for bodily injury other than to employees of the insured;
- (4) Claims for indemnity under Section 3.18 of the AIA A201-General Conditions contained in the Bidding Documents arising out of injury to employees of the insured;
- (5) Claims or loss excluded under a prior work endorsement or other similar exclusionary language;
- (6) Claims or loss due to physical damage under a prior injury endorsement or similar exclusionary language;
- (7) Claims related to roofing, if the Work involves roofing;

- (8) Claims related to exterior insulation finish systems (EIFS), synthetic stucco or similar exterior coatings or surfaces, if the Work involves such coatings or surfaces;
- (9) Claims related to earth subsidence or movement, where the Work involves such hazards;
- (10) Claims related to explosion, collapse and underground hazards, where the Work involves such hazards.

The Commercial General Liability coverage general aggregate limit shall apply separately to each project on a per-project basis and shall be unimpaired at commencement of the Work. The Commercial General Liability coverage shall be written on the most recent ISO occurrence form (CG 00 01) or a substitute occurrence-based form providing equivalent coverage, and shall include coverage for liability arising from premises, operations, independent contractors, products/completed operations covering construction means and methods to be maintained for no less than a period of seven (7) years after completion of the Work, personal and advertising injury, contractual liability (without requiring privity of contract), and liability assumed under an insured contract (including the tort liability of another assumed in a business contract). The Commercial General Liability coverage shall apply to, and not exclude coverage for: joint negligence of the Contractor and other persons; acts and/or omissions of Subcontractors and Subcontractors' sub-subcontractors; and completed operations. In addition, such policy shall contain a broad form contractual liability endorsement or similar wording within the policy form, if applicable.

Amity Regional School District No. 5 (the "Owner"), the Amity Regional School District No. 5 Board of Education, Amity Regional School District No. 5 High School Library Media Center Building Committee, and their members, affiliates, employees, volunteers, directors, and officers, shall be included as additional insureds under the Commercial General Liability policy, to the extent commercially available using an endorsement with coverage no less than that provided under CG 20 10 07 04, CG 20 37 07 04, and, with respect to Silver, Petrucelli & Associates, Inc. (the "Architect"), and the Architect's consultants, CG 20 32 07 04. Insurance for additional insureds shall be as broad as the coverage provided for the named insured. Commercial General Liability coverage shall apply as primary and non-contributory insurance before any other insurance or self-insurance, including any deductible maintained by or provided to the additional insureds.

B. Commercial Automobile Liability insurance written on the most recent ISO form CA 00 01 or its equivalent, covering vehicles owned, hired vehicles, and non-owned vehicles, including trailers, used by the Contractor and/or used in connection with the Work, with policy limits of not less than One Million Dollars (\$1,000,000) per accident, for bodily injury, death of any person, and property damage arising out of the ownership, maintenance and use of those motor vehicles along with any other statutorily required automobile coverage. If vehicles are used to transport hazardous material then ISO CA 99 48 (broadened pollution) and an MCS90 endorsement shall be included unless Pollution Liability coverage as described in Section I.H is applicable to operations and vehicles being used.

C. Umbrella or Excess liability insurance on an occurrence basis in excess of the coverages and limits required for the primary liability insurance required under Sections I.A, I.B, and I.F (Contractor's Commercial General Liability insurance, Commercial Automobile Liability insurance, and Employer's Liability insurance), in an amount not less than One Million Dollars (\$1,000,000) per occurrence and One Million Dollars (\$1,000,000) unimpaired general aggregate per policy year. Umbrella or Excess coverage shall be follow form on a primary and non-contributory basis. The Umbrella or Excess insurance policies shall provide the same or greater coverage as the Contractor's Commercial General Liability insurance, Commercial Automobile Liability insurance, and Employer's Liability insurance, and in no event shall any excess or umbrella liability insurance provide narrower coverage than the primary policy. The Umbrella or Excess insurance policy shall not require the exhaustion of the underlying limits only through the actual payment by the underlying insurers. Umbrella or Excess coverage must include as additional insureds all entities that are additional insureds on the Commercial General Liability coverage, Automobile Liability, and Employer's Liability insurance required under Sections I.A, I.B, and I.F, and Umbrella or Excess coverage for such additional insureds shall apply as primary and non-contributory before any other insurance or self-insurance or self-insured retention, including any deductible maintained by or provided to the additional insured, and shall apply without the need for privity of contract as to any additional insured.

D. The Contractor may achieve the required limits and coverage for Commercial General Liability insurance, Automobile Liability insurance, and Employers' Liability insurance, through a combination of primary and excess or umbrella "follow form" liability insurance, provided such primary and excess or umbrella insurance policies result in the same or greater coverage as the coverages required under Sections I.A, I.B, and I.F, and in no event shall any excess or umbrella liability insurance provide narrower coverage than the primary policy. The excess policy shall not require the exhaustion of the underlying limits only through the actual payment by the underlying insurers, and aggregate limits of liability shall apply separately with respect to the Work.

E. Workers' Compensation at statutory limits.

In addition to any other requirements related to worker's compensation insurance, if Contractor is a sole proprietor, a single member limited liability company or otherwise has no employees, Contractor shall maintain Worker's Compensation Insurance as if it were an "employer" as such term is defined in and in accordance with Connecticut's General Statutes.

F. Employers' Liability insurance with policy limits not less than Five Hundred Thousand Dollars (\$500,000) each accident, Five Hundred Thousand Dollars (\$500,000) each employee, and Five Hundred Thousand Dollars (\$500,000) policy limit.

G. If the Contractor is required to furnish professional services as part of the Work, including without limitation, surveying, design, engineering, stamping of drawings or specifications, consulting, programing or development of software, the Contractor shall procure Professional Liability insurance covering performance of the professional services, with policy limits of not less than One Million Dollars (\$1,000,000) per occurrence or claim and One Million Dollars (\$1,000,000) in the aggregate. If Professional Liability insurance procured and maintained is on claims-made basis, the insurance policy shall have a retroactive date which shall precede the commencement of the Work and which date is no later than the policy inception date, and coverage shall be continuously maintained until at no less than three (3) years after Substantial Completion of the Project.

H. If the Work involves the handling, abatement, clean-up, removal, transport, dissemination, use, or release of pollutants or hazardous materials, including but not limited to asbestos, PCBs, contaminated soils, and lead-based paint, the Contractor shall procure Pollution Liability insurance, with policy limits of not less than One Million Dollars (\$1,000,000) per occurrence and One Million Dollars (\$1,000,000) in the aggregate. The policy shall provide coverage for pollution, lead, mold and asbestos liability. The policy must specifically include coverage for "asbestos, lead paint, and other hazardous building materials such as PCB's, abatement operations" and have the "Pollution Exclusion" eliminated or modified so as not to apply to any bodily injury, including but not limited to asbestos, lead paint, and other hazardous building materials such as PCB's abatement, handling, transport or disposal. All policies shall be written on an "occurrence" basis. Coverage shall include first party, third party, clean-up, legal and claim expense including transit and disposal. Full policy forms and endorsements are subject to review by the Owner.

I. Coverage under Section I.G and I.H may be procured through a Combined Professional Liability and Pollution Liability insurance policy, with combined policy limits of not less than Two Million Dollars (\$2,000,000) per claim and Two Million Dollars (\$2,000,000) in the aggregate.

J. The Contractor's Commercial General Liability, Umbrella/Excess Liability, Automobile Liability, and Worker's Compensation Insurance policies shall include a waiver of subrogation endorsement in favor of Amity Regional School District No. 5, the Amity Regional School District No. 5 Board of Education, Amity Regional School District No. 5 High School Library Media Center Building Committee, and their members, affiliates, employees, volunteers, directors, and officers.

K. Additional Insured Obligations.

1. To the fullest extent permitted by law, the Contractor shall cause the commercial general liability coverage, automobile liability coverage, and excess or umbrella coverage to include (1) Amity Regional School District No. 5, the Amity Regional School District No. 5 Board of Education, Amity Regional School District No. 5 High School Library Media Center Building Committee, and their members, affiliates, employees, volunteers, directors, and officers, the Architect, and the Architect's consultants, as additional insureds for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's operations; and (2) Amity Regional School District No. 5, the Amity Regional School District No. 5 Board of Education, Amity Regional School District No. 5 High School Library Media Center Building Committee, and their members, affiliates, employees, volunteers, directors, and officers, as additional insureds for claims caused in whole or in part by the Contractor's negligent acts or omissions for which loss occurs during completed operations. The additional insured coverage shall be primary and non-contributory to any general liability insurance policies maintained by the Owner or any other additional insured and shall apply to both ongoing and completed operations. To the extent commercially available, the additional insured coverage shall be no less than that provided by Insurance Services Office, Inc. (ISO) forms CG 20 10 07 04, CG 20 37 07 04, and, with respect to the Architect and the Architect's consultants, CG 20 32 07 04.

2. The Owner, the Architect, and the Architect's consultants, and all of their affiliates, subsidiaries and respective partners, officers, directors, agents, employees and servants, shall be named as an additional insured on the insurance policies described in Sections I.A, I.B, I.C, I.F, I.H, and I.I, without a requirement for privity of contract. The additional insured coverage in such policies procured by the Contractor, as named insured, shall not limit coverage thereunder to vicarious liability of the additional insured or liability arising out of only the named insured's negligence.

L. All insurance policies maintained by the Contractor shall be deemed primary and non-contributory to insurance maintained by any additional insured, up to and including the limits of any Umbrella or Excess coverage, in the event of loss arising out of the Contractor's performance of the Work, and all such insurance policies shall provide that where there is more than one insured thereunder the policy shall apply to each insured separately as if there were a separate policy covering each insured except with respect to the policy limits of such policy. The Contractor shall obtain certificates for each policy which evidence that coverage is in accordance with these requirements.

M. To the fullest extent permitted by law, the Contractor, for itself and its insurers, shall waive all rights of recovery and all rights of subrogation against Amity Regional School District No. 5, the Amity Regional School District No. 5 Board of Education, Amity Regional School District No. 5 High School Library Media Center Building Committee, and their members, affiliates, employees, volunteers, directors, and officers, the Architect, and the Architect's consultants, and their subsidiaries, affiliates, employees, volunteers, directors and officers, and any other person designated by the Owner or with whom the Owner has agreed to waive its rights in the event of loss including loss which should have been covered by the insurance required pursuant to the Contract Documents to be procured and maintained by the Contractor, for losses within the scope of any liability insurance policy which the Contractor is required to purchase and maintain pursuant to the Contract Documents and/or covered by any liability insurance policy which the Contractor in-fact purchases and maintains.

N. To the extent commercially available, all insurance policies required to be procured by the Contractor pursuant to the this Exhibit A and/or the Contract Documents and/or which the Contractor in-fact procures in connection with the Work and/or which otherwise apply to the Work or the Project, shall not prohibit and shall permit the Contractor to waive rights of subrogation against, and shall include a waiver of subrogation endorsement in favor of Amity Regional School District No. 5, the Amity Regional School District No. 5 Board of Education, Amity Regional School District No. 5 High School Library Media Center Building Committee, and their members, affiliates, employees, volunteers, directors, and officers, the Architect, and the Architect's consultants, and its subsidiaries, affiliates, employees, volunteers, directors and officers, and agents.

O. Limits of coverage stated above for any insurance are minimum required amounts, and if higher limits of coverage are maintained for any coverage such higher limits will be deemed to be those required by this Exhibit A and/or the Contract. Minimum coverage limits required for insurance required to be procured and maintained by the Contractor may be satisfied through any combination of primary and umbrella or excess coverage, provided there shall be no gaps in the form or limits between primary and umbrella or excess coverage. Policy limits available to any additional insured shall be the full policy limits maintained by the named insured. The amounts of insurance specified herein and agreed to by the parties are minimum requirements only and shall in no way limit the liability of the Contractor, nor the applicability or availability of the Contractor's insurance.

II. Additional General Insurance Requirements

A. Certificates of Insurance. The Contractor shall provide current certificates of insurance acceptable to the Owner evidencing compliance with the insurance requirements set forth herein and the other Bidding Documents at the following times: (1) prior to commencement of the Work; (2) upon renewal or replacement of each required policy of insurance; and (3) upon the Owner's written request. An additional certificate evidencing continuation of commercial liability coverage, including coverage for completed operations, shall be submitted with the final Application for Payment and thereafter upon renewal or replacement of such coverage until the expiration of the periods required by Section I, above. The certificates will show Amity Regional School District No. 5, the Amity Regional School District No. 5 Board of Education, Amity Regional School District No. 5 High School Library Media Center Building Committee, and their members, affiliates, employees, volunteers, directors, and officer as additional insureds on the Contractor's Commercial General Liability, Automobile Liability, and excess or umbrella liability policy or policies. The Contractor's policies shall be written by insurance companies licensed to do business in the State of Connecticut, with an AM Best rating of no less than A-, IX or otherwise acceptable to the Owner. The Contractor and its insurer(s) for each liability insurance policy required under this Exhibit A and/or any other Contract Documents shall give the Owner and any additional insured under any such policy, no less than thirty (30) days' prior written notice in advance of any termination, expiration, cancellation, or reduction or other change in coverage, and in advance the date by which renewal is required to continue coverage under any such policy, and (10) days' prior written notice of a termination or cancellation of a policy for non-payment. All certificates of insurance and notices required pursuant to the Contract Documents shall be sent by registered mail:

Theresa Lumas, Director of Finance
Amity Regional School District #5
25 Newton Road
Woodbridge, CT 06525

B. The Contractor shall provide evidence of coverage that meets the requirements of the Contract Documents (including without limitation this Exhibit A) by providing to the Owner certificates of insurance for each policy, and if requested by the Owner redacted certified copies of such policies or any part thereof deemed necessary in the sole opinion of the Owner to demonstrate compliance with the Contractor's obligations under the Contract. The Owner's acceptance of evidence of insurance shall in no way constitute or be construed as the Owner's affirmation that the Contractor has fully satisfied any or all of such obligations or the Owner's waiver of any right or claim arising out of or relating to the Contract Documents. As soon as possible after the execution of the Contract, and in no event later than seven (7) days prior to the commencement of the Work, the Contractor shall provide to the Owner certificates of insurance and/or certified copies of the policies requested by the Owner as evidence that all insurance coverage required pursuant to the Contract Documents to be procured and maintained by the Contractor during performance of the Work has been so procured. The Contractor nor any Subcontractor may perform activities for construction of the Work at or on the Project site prior to Contractor's delivery of such evidence to the Owner, and no failure to or delay in delivering such evidence to the Owner shall constitute a basis for any increase to the Contract Sum or the Contract Time.

C. Deductibles and Self-Insured Retentions. The Contractor shall disclose to the Owner any deductible or self-insured

retentions applicable to any insurance required to be provided by the Contractor. Any retention or deductible applicable on any insurance policy procured and maintained by the Contractor shall be clearly stated and shall be the sole responsibility of the Contractor together with any applicable premium charge, claim cost, penalties, assessment, tax or other costs associated with the Contractor's risk funding obligations. Self-insured retention or any deductible in excess of \$100,000 shall require the Owner's prior written approval.

D. The Contractor shall ensure that all Subcontractors maintain insurance policies, written by insurance companies licensed to do business in the State of Connecticut with an AM Best rating of no less than A-, VII, which policies are consistent with the requirements set forth in this Exhibit A and otherwise in the Contract, including without limitation, the naming of additional insureds as provided and required in Section I, above, with coverage limits not less than those required for the insurance policies required to be procured and maintained by the Contractor or such lower limits as are agreed to by the Owner in writing on a case-by-case basis for a specific Subcontractor. The Contractor shall include in all subcontract agreements the obligation of the Subcontractors to comply with these insurance requirements. The Contractor shall not permit any Subcontractor or sub-subcontractor to perform any Work on the Project site until such time as the Contractor has obtained satisfactory evidence from such Subcontractors and sub-subcontractors that the foregoing insurance requirements have been satisfied.

E. The Contractor shall require all its Subcontractors and their insurers to waive all rights of recovery against Amity Regional School District No. 5, the Amity Regional School District No. 5 Board of Education, Amity Regional School District No. 5 High School Library Media Center Building Committee, and their members, affiliates, employees, volunteers, directors, and officers, and the Architect, and the Architect's consultants, and their subsidiaries, affiliates, employees, volunteers, directors and officers, and any other person designated by the Owner or with whom the Owner has agreed to waive its rights in the event of loss, for losses covered by any policy of liability insurance which any such Subcontractor is required to purchase and maintain pursuant to the Contract Documents and/or their Subcontract with the Contractor in connection with the Work, and/or which the Subcontractor in-fact purchases and maintains in connection with the Project and/or the Work.

F. If, as a result, in whole or in part, of the negligence (or other act for which there is legal liability) of the Contractor, its employees, agents, or subcontractors of any tier, any person (including employees of the Contractor) injury or death occurs or any property is damaged, lost or destroyed, or any other loss occurs, the Contractor assumes the liability therefor and agrees, to the fullest extent permitted by law, to indemnify, defend, and hold the Owner and its affiliates, subsidiaries, partners, directors, officers, members, managers, agents, servants, employees, and volunteers harmless from any and all such injury, death, property damage or other loss, including reasonable attorneys' fees incurred in connection therewith. The foregoing obligations are independent from, and not limited in any manner by, the Contractor's insurance coverage obtained pursuant to the Contract Documents or otherwise. The Contractor shall not be required to defend, indemnify or hold harmless an indemnitee against claims for bodily injury or property damage solely caused by or resulting from the negligence of such indemnitee.

AIA® Document A201® – 2017

General Conditions of the Contract for Construction

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

Media Center Interior Alterations at Amity Regional High School-Phase 1 of 2
25 Newton Road
Woodbridge, CT 06525 (the “Project”)
State Project Number: 205-0046A

THE OWNER:
(Name, legal status and address)

Amity Regional School District #5 (“Owner”)
25 Newton Road
Woodbridge, CT 06525

THE ARCHITECT:
(Name, legal status and address)

Silver/Petrucci + Associates, Inc.
3190 Whitney Avenue
Hamden, CT 06518

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- 10 PROTECTION OF PERSONS AND PROPERTY
- 11 INSURANCE AND BONDS

ADDITIONS AND DELETIONS:
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ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

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

§ 1.1.2 The Contract

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

§ 1.1.3 The Work

The term "Work" means the construction and services required by, reasonably inferable from, and as necessary to produce the results intended by, the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations or to be provided by Subcontractors, material suppliers, Sub-subcontractors or any other entity for whom the Contractor is responsible under or pursuant to the Contract Documents. The Work may constitute the whole or a part of the Project.

§ 1.1.4 The Project

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

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location, and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams. The Drawings and details for construction and changes to the Work show layouts as taken from available original Drawings and subsequent known changes. The Contractor shall make all necessary adjustments and changes in the construction of the Work required by actual conditions existing on the date of the Agreement, at no cost to the Owner.

§ 1.1.6 The Specifications

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

§ 1.1.7 Instruments of Service

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

§ 1.1.8 Initial Decision Maker

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

§ 1.9 Contractor

The term “Contractor” as used in these General Conditions or any of the Contract Documents, shall mean and refer to the person identified as the “Contractor” in the Agreement.

§ 1.2 Correlation and Intent of the Contract Documents

§ 1.2.1 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results. If the Contractor discovers any inconsistency within or among parts of the Contract Documents which set forth the requirements for the Work, or between the requirements for the Work set forth in Contract Documents and applicable standards, codes or ordinances, the Contractor shall promptly give notice to the Owner and the Architect of such inconsistency and shall, unless otherwise instructed in writing by the Architect or the Owner, provide work or materials that comply with applicable standards, codes or ordinances, and if not in conflict with such standards, codes and ordinances, further provide work or materials of the better quality and/or greater quantity set forth in the Contract Documents as instructed by the Architect or the Owner. In the case of an inconsistency between the Drawings and Specifications, or within either that is not clarified by Addendum, the better quality or greater quantity of Work shall be provided in accordance with the Architect’s interpretation.

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

§ 1.2.2 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

§ 1.2.3 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings. When applied to materials and equipment required for the Work, the words “furnish,” “install,” and “provide” shall be interpreted as follows:

- .1 The word “provide” shall mean to furnish, pay for, deliver, install, adjust, clean, and otherwise make materials and equipment fit and ready for their intended use.
- .2 The word “furnish” shall mean to secure, pay for, deliver to site, unload, and uncrate materials and equipment.
- .3 The word “install” shall mean to place in position, incorporate in the Work, adjust, clean, make fit and ready for use and perform all services except those included under the term “furnish”
- .4 The phrase “furnish and install” shall be equivalent to the word “provide.” Each shall be interpreted to mean ‘the Contractor shall furnish all labor, material and equipment and install.’
- .5 “As required” shall mean as required to produce a fully completed project or result to the satisfaction of the Architect
- .6 Where irreconcilable conflicts between different Contract Documents occur:
 - .1 Amendments and Addenda shall take precedence over the Specifications.
 - .2 The Specifications shall take precedence over the Drawings.
 - .3 Stated dimensions shall take precedence over scaled dimensions.
 - .4 Large-scale detail drawings shall take precedence over small-scale drawings.
 - .5 Schedules shall take precedence over other data on the drawings.
- .7 In case of a difference between Drawings or Specifications or within either document itself in describing the Work, the better quality or greater quantity, regardless of cost, will be assumed to be and shall be included in the Work. The Contractor shall not proceed with such Work until the Architect has been contacted for clarification and proper direction.
- .8 Schedules of materials in various sections of the Specifications are furnished to assist the Contractor. Contractor shall verify the schedules with the Drawings and shall provide any additional materials indicated on the Drawings but not included in the schedules. The greater quantity or highest quality will govern.

§ 1.2.4 All work shown or referred to in the Contract Documents shall be included in the Work, excepting only those items

which are specifically noted as not being part of the Work and/or noted “note in contract (NIC)”, or specifically noted as to be provided by the Owner.

§ 1.2.5 The Contractor shall not take advantage of obvious error or apparent discrepancy in Contract Documents. Notice of discovered error or discrepancy shall immediately be given in writing to the Architect to make such corrections and interpretations as the Architect may deem necessary for completion of the Work in accordance with the requirements of the Contract Documents.

§ 1.3 Capitalization

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

§ 1.4 Interpretation

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

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

§ 1.5.1 The Contractor, Subcontractors, Sub-subcontractors, and suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with the Project is not to be construed as publication in derogation of the reserved rights of the Owner in and to such Instruments of Service.

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

§ 1.6 Notice

§ 1.6.1 Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if a method for electronic transmission is set forth in the Agreement.

§ 1.6.2 Notice of Claims as provided in Section 15.1.3 shall be provided in writing and shall be deemed to have been duly served only if delivered to the designated representative of the party to whom the notice is addressed by certified or registered mail, or by courier providing proof of delivery.

§ 1.7 Digital Data Use and Transmission

The parties shall agree upon written protocols governing the transmission and use of, and reliance on, Instruments of Service or any other information or documentation in digital form.

§ 1.8 Building Information Models Use and Reliance

Any use of, or reliance on, all or a portion of a building information model without agreement to written protocols governing the use of, and reliance on, the information contained in the model shall be at the using or relying party’s sole risk and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.

ARTICLE 2 OWNER

§ 2.1 General

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner’s approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term “Owner” means the Owner or

the Owner's authorized representative. The Owner's representative shall be the person designated as such in the Agreement, or a successor to such person designated by the Owner from time to time, which person shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization, subject to such limitations as the Owner may specify in writing to the Contractor from time to time. Any action taken on the Owner's behalf other than by the representative so designated by Owner will not be binding upon the Owner. The Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative. The Owner will provide written notification to the Contractor of the identity and contact information of any person (other than the person identified in Section 8.2 of the Agreement) that is to serve as a designated representative of the Owner.

§ 2.1.2 Intentionally omitted.

§ 2.2 Evidence of the Owner's Financial Arrangements

§ 2.2.1 Prior to commencement of the Work, upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. If such evidence is so requested, the Contractor shall have no obligation to commence the Work until the Owner provides such evidence.

§ 2.2.2 Intentionally omitted.

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

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

§ 2.3 Information and Services Required of the Owner

§ 2.3.1 Except for permits, related fees and filings that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure, file and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities, unless provided otherwise in the Contract Documents.

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

§ 2.3.3 If the employment of the Architect terminates, the Owner shall employ a successor provided the services of the Architect are still needed for the Project at the time of termination.

§ 2.3.4 The Owner shall furnish surveys describing the general physical characteristics, legal limitations, and utility locations for the site of the Project. The Contractor shall be entitled to rely on the accuracy of such surveys to extent such documents affirmatively describe or identify the general physical characteristics, legal limitations, and utility locations for the site of the Project. Notwithstanding any information contained in any such surveys received by the Contractor, the Contractor shall at all times exercise proper precautions relating to the safe performance of the Work. Any other data provided by the Owner to the Contractor concerning the physical characteristics or measurements of the components that comprise the Project site; access to the Project site or staging and storing at the Project site; present obstructions and conditions of structures on or near the Project site; locations and depths of sewers, conduits, pipes, and gas lines on or near the Project site; positions of sidewalks, curbs and pavements on or near the Project site and other data concerning the conditions of the Project site and its surroundings (collectively, "Site Data"), have been obtained from sources the Owner believes to be reliable. Accuracy of the Site Data, however, is not guaranteed and is furnished solely for accommodation of the Contractor.

§ 2.3.5 The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall furnish such information and services with reasonable promptness after receiving the Contractor's written request for such information or services.

§ 2.3.6 Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor, without charge, three (3) copies of Drawings and Project Manual. Additional requested by the Contractor will be furnished at the cost of reproduction, postage and handling.

§ 2.4 Owner's Right to Stop the Work

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

§ 2.5 Owner's Right to Carry Out the Work

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a five-day period after receipt of notice from the Owner to commence and continue correction of such default or neglect, and all deficiencies in the Work arising therefrom, with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect and the deficiencies in the Work arising therefrom. In such case, an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor for the Owner's cost of correcting the default or neglect and the deficiencies in the Work arising therefrom, including, without limitation, expenses, attorneys' fees, and compensation for the Architect's additional services made necessary by such default, neglect, failure and deficiencies. The Contractor shall also be responsible for all the Owner's other costs, damages, delays, and associated impacts arising in the event that the Owner exercises its rights under this Section 2.5. The Architect may, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent necessary to pay the Owner the amounts due under this Section 2.5. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Architect, or the amounts claimed as costs to the Owner, the Contractor may file a Claim pursuant to Article 15. The right of the Owner to carry out the Work pursuant to this Section 2.5 shall not give rise to any duties on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity. In performing any work pursuant to this Section 2.5, the Owner shall have the right to take possession of the site and of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor or any Subcontractor.

§ 2.6 Additional Rights

The rights stated in this Article 2 shall be in addition to, and not in limitation of, any other rights of the Owner provided in the Contract Documents, or as may be available to the Owner at law or in equity.

ARTICLE 3 CONTRACTOR

§ 3.1 General

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

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

§ 3.1.2.1 Unless explicit quality or standards for materials or workmanship are established in the Contract Documents for any portion of the Work with which the Contractor is obligated to comply, the Contractor shall perform such Work in a good and workman like manner, in a manner of good quality for the intended use, and consistent with the quality of the surrounding Work and of the construction of the Project generally.

§ 3.1.2.2 All manufactured articles, materials and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned in accordance with the manufacturer's written or printed directions and instructions unless otherwise specifically indicated in the Contract Documents. The Contractor shall comply with all manufacturer's directions, specifications and recommendations for installation, handling, sorting, adjustment and operation of materials or equipment; provided, the Contractor shall be responsible for determining whether any such directions, specifications and recommendations may safely and suitably be employed in the Work, and for notifying the Owner and Architect in advance, in writing, of any deviation or modification necessary for the safe installation or proper operation of the item of material or equipment.

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

§ 3.1.4 The Contractor shall comply, and shall cause Subcontractors of every tier to comply, with all accounting procedures and record retention policies reasonably requested by the Owner.

§ 3.1.5 Non-Resident Contractor

If the Contractor is a "nonresident contractor" as defined in Section 12-430(7)(A) of the Connecticut General Statutes, as revised, the Contractor shall provide evidence to the Owner prior to commencement of the Work that Contractor has complied fully with the provisions of Section 12-430(7). The Contractor is hereby notified that, if any Subcontractor or supplier performing any part of the Work under the Contract Documents is a nonresident unverified contractor, the Contractor will withhold 5% of all payments to such Subcontractor or supplier unless and until such Subcontractor or supplier provides to the Contractor a Certificate of Compliance issued by the Connecticut Department of Revenue Services as defined in the Connecticut General Statutes Section 12-430(7). A nonresident unverified contractor is a contractor without an office in the State of Connecticut that is continuously maintained, occupied and used by the contractor's regular employees regularly in attendance to carry on the contractor's business in the contractor's own name and which contractor has not been verified pursuant to the requirements of the Connecticut Department of Revenue Services. The amount withheld pursuant to Connecticut General Statutes Section 12-430(7) shall be in addition to, and not in lieu of, the retainage held by the Contractor under its Subcontract with the Subcontractor or supplier.

§ 3.1.6 Notwithstanding anything to the contrary in the Contract Documents, the Contractor shall attend such meetings and site-visits, and make such submissions, as are necessary to comply with applicable Legal Requirements (as defined in the Agreement).

§ 3.1.7 Nondiscrimination

§ 3.1.7.1 Pursuant to the requirements of Connecticut General Statutes Section 4a-60:

- (a) (1) The Contractor agrees and warrants that in the performance of the Contract such Contractor will not discriminate or permit discrimination against any person or group of persons on the grounds of race, color, religious creed, age, marital status, national origin, ancestry, sex, sexual orientation, gender identity or expression, status as a veteran, status as a victim of domestic violence, status as a victim of sexual assault or status as a victim of trafficking in persons, intellectual disability, mental disability or physical disability, including, but not limited to, blindness, unless it is shown by such Contractor that such disability prevents performance of the Work involved, in any manner prohibited by the laws of the United States or of the state of Connecticut; and the Contractor further agrees to take affirmative action to ensure that applicants with job-related qualifications are employed and that employees are treated when employed without regard to their race, color, religious creed, age, marital status, national origin, ancestry, sex, gender identity or expression, sexual orientation, status as a veteran, status as a victim of domestic violence, status as a victim of sexual assault or status as a victim of trafficking in persons, intellectual disability, mental disability or physical disability, including, but not limited to, blindness, unless it is shown by such Contractor that such disability prevents performance of the Work involved;
- (2) The Contractor agrees, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, to state that it is an "affirmative action-equal opportunity employer" in accordance with regulations adopted by the Connecticut Commission on Human Rights and Opportunities;
- (3) The Contractor agrees to provide each labor union or representative of workers with which such

Contractor has a collective bargaining agreement or other contract or understanding and each vendor with which such Contractor has a contract or understanding, a notice to be provided by the Connecticut Commission on Human Rights and Opportunities advising the labor union or worker's representative of the Contractor's commitments under this section, and to post copies of the notice in conspicuous places available to employees and applicants for employment;

(4) The Contractor agrees to comply with each provision of Section 4a-60 of the Connecticut General Statutes, Connecticut General Statutes Sections 46a-68e and 46a-68f, and with each regulation or relevant order issued by the Connecticut Commission on Human Rights and Opportunities pursuant to Connecticut General Statutes Sections 46a-56, 46a-68e, 46a-68f and 46a-86; and

(5) The Contractor agrees to provide the Connecticut Commission on Human Rights and Opportunities with such information requested by the commission, and permit access to pertinent books, records and accounts, concerning the employment practices and procedures of the Contractor as relate to the provisions of Connecticut General Statutes Sections 4a-56 and 4a-60.

(b) The Contractor agrees and warrants that it will make good faith efforts to employ minority business enterprises as subcontractors and suppliers of materials on the Project.

(c) Pursuant to Connecticut General Statutes Section 4a-60(g), the Contractor shall include the provisions of subsections (a) and (b) of this Section 3.1.7.1 in every subcontract or purchase order entered into in order to fulfill any obligation of a contract with the state, and in every subcontract entered into in order to fulfill any obligation of a public works contract, and such provisions shall be binding on a subcontractor, vendor or manufacturer, unless exempted by regulations or orders of the Commission on Human Rights and Opportunities. The Contractor shall take such action with respect to any such subcontract or purchase order as the commission may direct as a means of enforcing such provisions, including sanctions for noncompliance in accordance with Connecticut General Statutes Section 46a-56; provided, if the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the commission regarding a state contract, the contractor may request the State of Connecticut to enter into any such litigation or negotiation prior thereto to protect the interests of the state and the state may so enter.

(d) The Contractor agrees to comply with the regulations referred to in this Section 3.1.7.1 as they exist on the date of the Contract and as they may be adopted or amended from time to time during the term of this Contract and any amendments thereto.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ 3.2.1 Execution of the Contract by the Contractor shall constitute a representation that the Contractor has (i) visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with requirements of the Contract Documents, and (ii) evaluated and satisfied itself and will cause its Subcontractors to satisfy themselves as to the conditions and limitations under which the Work is to be performed, including, without limitation (1) the location, condition, layout and physical conditions of the Project site and surrounding areas, (2) generally prevailing climatic conditions, (3) anticipated labor supply and costs, (4) anticipated availability and costs of materials, tools and equipment, and (5) except as provided in Section 10.3, and subject to the provisions of Section 3.7.4, anticipated soil and subsurface conditions of the Project site. Failure by the Contractor to comply with this Section 3.2.1 and to fully acquaint itself with conditions which may affect the Work and/or the cost thereof, including, but not limited to, conditions relating to transportation, handling, storage of materials, availability of labor, water, other known projects in the region, applicable provisions of law, and the character and availability of equipment and facilities needed preliminary to and during the prosecution the Work, shall not relieve the Contractor of its responsibilities under the Contract Documents and shall not constitute a basis for extension of the Contract Time or any increase in the Contract Sum. The Owner shall not be required to pay any amount, including any increase in the Contract Sum, or make any adjustment in the Contract Time, in connection with any failure by the Contractor or any Subcontractor to comply with the requirements of this Section 3.2.1. Owner assumes no responsibility for any representations concerning conditions made by any of its officers, or employees or representatives, prior to the execution of the Contract, unless such representations are expressly stated in the Contract Documents. The provisions of this Section 3.2.1 shall not be construed to limit the investigative and review responsibilities of the Contractor under any other provisions of the Contract Documents. The provisions of this Section 3.2.1 shall not be construed to limit the investigative and review responsibilities of the Contractor under any other provisions of the Contract Documents.

§ 3.2.1.1 Execution of the Contract by the Contractor shall constitute a representation by the Contractor that the Contractor has carefully reviewed the Contract Documents, and that the Contract Documents are sufficiently detailed and complete to permit the Contractor, (i) to complete the Project for an amount not in excess of the Contract Sum; and (ii) complete the Work within the Contract Time and in accordance with the Contract Documents and all applicable Legal Requirements (as defined in Section 3.7.2). The Contractor shall not perform any construction activity it knows constitutes a recognized error, inconsistency, or omission. If the Contractor performs any construction activity knowing it involves a recognized error, inconsistency, or omission in the Contract Documents without reporting the error, inconsistency or omission to the Architect, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the costs of correction.

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

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

§ 3.2.4 If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall submit Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay such costs and damages to the Owner as would have been avoided if the Contractor had performed such obligations and the Contractor shall be responsible for associated delays and impacts. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages resulting from errors, inconsistencies or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities. If the Contractor proceeds with such Work without obtaining further Drawings or instructions from the Owner, or without providing prompt prior written notification to the Architect and Owner, the incorrect or improperly completed/attempted Work shall be corrected by the Contractor's at its expense.

§ 3.2.5 If the Contractor fails to fulfill its obligations to report to the Architect or Owner under this Article 3, such failure shall preclude the Contractor from any subsequent Claim arising from or relating to the factors giving rise to the Contractor's obligation to make such report.

§ 3.2.6 The Owner assumes no contractual liability or responsibility for the physical condition or safety of the Project site or of any improvements thereon. Except as set forth in Section 10.3, the Contractor shall be solely responsible for providing safe conditions for the performance of the Work.

§ 3.2.7 If the Contractor shall give the Architect notice of any additional Drawings, Specification or instructions required to define the Work in greater detail, or to permit the proper progress of the Work. Requests for such information shall be made by the Contractor sufficiently in advance of the time such information is needed by the Contractor so as to permit the Architect a reasonable time for responding to such requests without affecting the progress of the Work.

§ 3.3 Supervision and Construction Procedures

§ 3.3.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences, and procedures, and for coordinating all portions of the Work under the Contract. In no event shall the Contractor employ

construction means, methods, techniques, sequences, or procedures that violate (1) requirements of any warranties applicable to the Work; or (2) any Legal Requirements.

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

§ 3.3.3 The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

§ 3.3.4 The Contractor shall furnish sufficient forces, plant and equipment as may be necessary to insure the progress of the Work in accordance with the Construction Schedule. If, in the opinion of the Owner, the Contractor has fallen behind the Construction Schedule, the Contractor shall submit its proposal demonstrating the manner in which the desired rate of progress may be achieved and the Contractor shall take such steps as may be necessary to meet the Construction Schedule. Unless the Contractor has fallen behind schedule due to delays which entitle Contractor to an adjustment in the Contract Time in accordance with the terms and conditions of the Contract Documents, the taking of such steps shall be at the sole costs and expense of the Contractor. It shall be the responsibility of the Contractor to maintain its schedule so as not to delay the progress of the Work or the scheduled work of separate contractors.

§ 3.3.5 The Contractor's coordination of Work shall include, without limitation, review of all shop drawings (including, without limitation, architectural, civil, structural, mechanical, and electrical shop drawings) submitted by Subcontractors for various trades or subdivisions of work, as indicated by Contractor's approval in accordance with Section 3.12.

§ 3.3.6 The Contractor shall be solely responsible for properly laying out the Work, and for all lines, elevations, and measurements for all of the Work. Contractor shall verify the figures shown on the Drawings before laying out the Work and will be responsible for any errors or inaccuracies resulting from Contractor's failure to do so. In the event that the Contractor shall, while laying out the Work, become aware of: (1) any conflicts between (a) the Drawings, the Specifications or any Modification to the Drawings or the Specifications and (b) the actual layout of the Work, or (2) any conflicts or inconsistencies in the Drawings, the Specifications or any Modification to the Drawings or the Specifications themselves, Contractor shall promptly notify the Architect. If the Contractor proceeds without the Architect's clarification and instruction on the matter, the Contractor shall proceed at Contractor's own risk.

§ 3.4 Labor and Materials

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

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

§ 3.4.3 All labor shall be performed by workmen skilled in their respective trades, and workmanship shall be of good quality so that first class work in accordance with the standards of construction set forth in the Contract Documents and the Contractor's Standard of Care will be achieved. The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. The Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them.

§ 3.4.3.1 The Contractor shall take all necessary steps to ensure harmony between persons performing labor as part of the Work. The Contractor shall perform Work in accordance with Legal Requirements, including regulations, applicable to the Project labor.

§ 3.4.3.2 The Contractor shall be solely responsible for the proper and safe operation and maintenance of all utility systems within the areas of site where the Work is performed, whether supplied by the Owner's distribution system or otherwise, until the Work is complete and accepted by the Owner and the Owner has notified the Contractor that other arrangements

for utility service have been made. The Contractor shall maintain, protect, and/or operate equipment or facilities within the site construction area which serve the distribution system, subject to periodic inspection by the Owner's on-site personnel. Inspection by any representative or personnel of the Owner shall not relieve the Contractor of responsibilities in connection with operation, maintenance and protection of these facilities and equipment. The Contractor shall notify the Owner's representatives no less than 72 hours in advance of the desire to extend, connect, disconnect, turn on or off any steam, electric, water or other service from the Owner's utility supply systems at the site. The actual operation shall be witnessed and approved by authorized representatives of the Owner. All plumbing, heating and electrical work, including installation of equipment and any other Work to be performed by the Contractor, shall be performed without interference with the Owner's normal operations at the site.

§ 3.4.3.3 The Owner will supply to the Contractor all water and electricity reasonably required for construction of the Work at the Project site. Utilities furnished by the Owner will be discontinued if, in the opinion of the Owner, wastefully used by the Contractor. The Contractor shall supply all hoses, extension cords, etc., necessary for the proper installation of the Work.

§ 3.4.3.4 Adequate toilet facilities for use during construction of the Work shall be provided by the Contractor.

§ 3.4.3.5 The Contractor shall be responsible for materials which are removed from the Work and to be subsequently re-installed as part of the Work. All cost, damage and loss of such materials while removed from the Work shall be the responsibility of the Contractor.

§ 3.4.4.1 As required under Section 31-53 of the Connecticut General Statutes, the wages paid on an hourly basis to any person performing the work of any mechanic, laborer or worker on the Work herein contracted to be done and the amount of payment or contribution paid or payable on behalf of each such person to any employee welfare fund, as defined in subsection (i) of Connecticut General Statutes Section 31-53, shall be at a rate equal to the rate customary or prevailing for the same work in the same trade or occupation in the Town of Woodbridge. If the Contractor or any Subcontractor is not obligated by agreement to make payment or contribution on behalf of such persons to any such employee welfare fund, the Contractor or such Subcontractor pay to each mechanic, laborer or worker as part of such person's wages the amount of payment or contribution for such person's classification on each pay day.

§ 3.4.4.2 As required pursuant to Connecticut General Statutes Section 31-53b, the Contractor shall furnish proof, and shall cause its Subcontractors to furnish proof, with the weekly certified payroll form for the first week each employee begins work on the Project that any person performing the work of a mechanic, laborer or worker pursuant to the classifications of labor under Connecticut General Statutes Section 31-53 on the Project, pursuant to such contract, has completed a course of at least ten hours in duration in construction safety and health approved by the federal Occupational Safety and Health Administration or, has completed a new miner training program approved by the Federal Mine Safety and Health Administration in accordance with 30 CFR 48 or, in the case of telecommunications employees, has completed at least ten hours of training in accordance with 29 CFR 1910.268 and that any plumber or electrician subject to the continuing education requirements of Connecticut General Statutes Section 20-334d, who has completed a course of at least ten hours in duration in construction safety and health approved by the federal Occupational Safety and Health Administration five or more years prior to the date such electrician or plumber begins work on the Project, has completed a supplemental refresher training course of at least four hours in duration in construction safety and health taught by a federal Occupational Safety and Health Administration authorized trainer.

§ 3.4.4.3 To the extent consistent with any provision regarding residence requirements contained in a collective bargaining agreement to which the Contractor is a party, in the employment of labor to perform the Work specified under the Contract Documents, preference shall be given by the Contractor to residents of the State of Connecticut, who are, and continuously for at least six (6) months prior to the date of this Agreement have been, residents of the State of Connecticut, and if no such person is available then to residents of other states.

§ 3.4.5 If the Contractor desires to substitute a product or method in lieu of what has been specified or shown in the Contract Documents, whether or not such phrases as "equal to" or "based on" are used, the Contractor shall propose to do so in a written request delivered to the Architect and the Owner in accordance with the Contract Documents, including without limitation Specification Section 012500 "Substitution Procedures." Any such request shall include all such data as the Architect requires to evaluate products. Any written request for a substitution by the Contractor shall be a representation by the Contractor to the Owner that: (1) the Contractor has investigated the product or method proposed to be substituted and found it to be equivalent to or better than the product or method specified in the Contract Documents,

(2) except to the extent otherwise expressly stated in such request, the Contractor is waiving any Claim for additional costs related to such substitution; (3) the Contractor will provide the same warranty for the substitution that the Contractor would for that specified; (4) the substitution will not entail changes in detail and construction of related Work; and (5) the Contractor shall coordinate the installation of the accepted substitution, making such changes as may be required for the Work to be complete in all respects. The Architect's decision shall be final. If any requested substitution is so approved by the Architect, the Contractor shall be responsible, at its sole cost and expense, for space requirements of the substitutions, execution of necessary changes in adjacent and relocated Work or affected parts of the building, execution of necessary changes in adjacent and relocated Work which resulting from such substitutions. The Contractor shall be responsible for any delays required for evaluation of proposed substitutions.

§ 3.4.5.1 Substitutions not properly approved and authorized in accordance with the Contract Documents, and work, materials or equipment which fail to perform under proper use and normal wear for intended purposes, may be deemed defective in the discretion of the Owner or the Architect. If required by the Architect or the Owner, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment to be incorporated in the Work.

§ 3.4.6 The Owner's prior written approval shall be required for the Contractor to utilize any "equal" materials or equipment other than a particular brand or make of material or equipment or "equal" specified in the Contract Documents.

§ 3.5 Warranty

§ 3.5.1 The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, a Subcontractor, Sub-subcontractor, supplier or any other person or entity for whom or which any of them is responsible, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ 3.5.2 The Contractor shall procure and assign to the Owner at the time of Substantial Completion of the Work any and all Subcontractor, manufacturer and supplier warranties relating to any materials, equipment and labor incorporated in the Work. Such warranties shall supplement the warranties provided by the Contractor in Section 3.5.1. All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.5.3

§ 3.5.3.1 Project Warranty: Unless otherwise specified, Contractor shall warrant (guaranty) all the Work against defects resulting from the use of material, workmanship or equipment which is inferior, defective, or not in accordance with the terms of the Contract. This warranty, unless stated otherwise in a given section of the Specifications, shall be for a period of one (1) year from the date of issuance of the Certificate of Substantial Completion for the Project.

§ 3.5.3.2 Specified Product Warranty is a warranty issued by a manufacturer or fabricator for compliance with requirements of the Contract Documents. Refer to sections of Specifications for requirements of specified warranties. The Contractor shall cause all Specified Product Warranties required by the Contract Documents to be issued for the benefit of the Owner.

§ 3.5.3.3 Coincidental Product Warranty is a warranty available on a product incorporated into the Work, by virtue of manufacturer's publication of warranty, without requiring a warranty application. The Contractor shall identify each Coincidental Product Warranty applicable to the Work.

§ 3.5.3.4 Warranty Obligations. Notwithstanding any other provision in these General Conditions:

- .1 the Contractor shall restore, or remove and replace, warranted Work to its originally specified condition, at such time during the applicable warranty as the Work does not comply with or fulfill the terms of such warranty;
- .2 the Contractor shall restore or remove and replace other Work which has been damaged by failure of warranted Work, or which must be removed and replaced to gain access to warranted Work;

- .3 the Contractor shall pay for and be solely responsible for the cost of restoration or removal and replacement of warrantied Work or Work affected by the Contractor's performance of its warranty obligations with respect to the Work, without regard to whether the Owner has already benefited from use of failing Work;
- .5 upon restoration or removal and replacement of warrantied Work, the Contractor shall reinstate the applicable warranty by issuing newly executed warranty documents for at least the remaining period of time of the original warranty, provided such warranty period shall not be less than half of the original warranty period;
- .6 warranties and warranty periods shall not diminish implied warranties, and shall not deprive the Owner of any rights or remedies otherwise available for the Contractor's failure to fulfill the requirements of the Contract Documents;
- .7 Owner reserves the right to reject product warranties which conflict with or are less than the requirements of the Contract Documents;
- .8 the Contractor shall furnish fully executed warranties to the Owner in accordance with these General Conditions and the Contract Documents.

§ 3.5.3.5 The Contractor shall furnish fully executed warranties to Owner in accordance with the Contract Documents, including without limitation, Specification Section 017700.

§ 3.5.4 The Contractor further agrees that each Subcontract shall contain a warranty of the portion of the Work performed thereunder in the same form as the above stated warranty of Contractor. Included in said warranty shall be the statement that it shall be enforceable directly by the Owner if the Owner so elects. The warranty of any Subcontractor shall not relieve the Contractor of its warranty as set forth above and the Owner may look to the Contractor, directly, and in the first instance to correct any defects in the Work.

§ 3.5.5 The representations and warranties under this Section 3.5 shall be in addition to, and not a substitute for, any other rights of the Owner under the Contract Documents or existing in law or equity.

§ 3.5.6 The representations and warranties set forth in this Section 3.5 shall survive final payment and termination of the Contract.

§ 3.6 Taxes

The Owner is exempt from the payment of sales, use and similar taxes. The Contractor shall be familiar with the current regulations of the Connecticut Department of Revenue Services and the sales or use tax on materials or supplies exempted by such regulations shall not be included in the Contract Sum. A sales tax certificate will be provided to the Contractor by the Owner upon request.

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, certifications and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and required by applicable Legal Requirements as of the effective date of this Contract. The Contractor shall provide the Owner and Architect with reproductions of all permits, licenses, permissions, certifications, and receipts for payments and, upon submission of the final Application for Payment, shall deliver all originals of such documents to the Owner with copies to the Architect.

§ 3.7.2 The Contractor shall comply with, be responsible for performance of the Work in accordance with, and give notices required by all applicable local, state and federal laws, statutes, ordinances, codes, building codes, rules, regulations, permits, and lawful orders enacted, promulgated, issued or ordered by any governmental body or public or quasi-public authority having jurisdiction over the Work, the Contractor and/ or the site of the Project (collectively, the "**Legal Requirements**"). Legal Requirements shall include, without limitation, those relating to equal opportunity, labor, wages and employment laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to the Project, the Contract, any Subcontract and/or the performance of the Work.

§ 3.7.3 If the Contractor performs Work knowing it to be contrary to applicable Legal Requirements, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than three (3) days after first observance of the conditions. The Architect will promptly investigate such conditions and, if the Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both. If the Architect determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the Owner and Contractor, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may submit a Claim as provided in Article 15.

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

§ 3.8 Allowances

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

§ 3.8.2 Unless otherwise provided in the Contract Documents,

- .1 allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- .2 Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and
- .3 whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

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

§ 3.9 Superintendent

§ 3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site at all times during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor. Important communications shall be confirmed in writing. Other communications shall be similarly confirmed upon written request in each case. The Contractor shall provide the Owner with after-hours telephone numbers by which the superintendent may be contacted in the event of an emergency.

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

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

unreasonably be withheld or delayed. The list of all supervisory personnel, including the project manager and superintendent that the Contractor intends to use on the Project shall be submitted to the Owner for approval prior to the commencement of the Work. The Contractor shall not engage supervisory personnel other than as approved by Owner. The Contractor shall not change and/or replace such personnel without prior written notice to and approval from the Owner (except in the case where such personnel's employment with Contractor has terminated), and shall not change or replace such supervisory personnel with any individual who does not have equivalent or superior experience and qualifications than the person to be replaced by such individual.

§ 3.10 Contractor's Construction and Submittal Schedules

§ 3.10.1 The Contractor, promptly after being awarded the Contract, and no later than the Project pre-construction conference, shall submit for the Owner's and Architect's approval, a proposed construction schedule for the Work. The proposed construction schedule (i) shall comply with all of the applicable requirements of, and shall not exceed time limits current under, the Contract Documents, (ii) shall be in such form and detail and include such content as required by the Owner, (iii) shall be related to the entire Project to the extent required by the Contract Documents, (iv) shall provide for expeditious and practicable execution of the Work for completion within the time limits current under the Contract Documents; (v) shall include the date of commencement of the Work, interim schedule milestone dates, and the date required for Substantial Completion; and (vi) shall include an apportionment of the Work by construction activity and the time required for completion of each portion of the Work. If the Owner requires a precedence-style critical path method (CPM) schedule, the proposed construction schedule shall also: (a) provide a graphic representation of all activities and events that will occur during performance of the Work; (b) identify each phase of construction and occupancy (if applicable); and (c) set forth dates that are critical in ensuring the timely and orderly completion of the Work (hereinafter referred to as "Milestone Dates"). If the proposed construction schedule is not accepted by the Owner, the Contractor shall promptly modify the proposed construction schedule in accordance with the recommendations of the Owner and the Architect and resubmit the revised schedules for acceptance. The schedule shall be revised at appropriate intervals as required by the conditions of the Work and Project.

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

§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent construction schedules submitted to and approved by the Owner and Architect (as so approved, the "Construction Schedule").

§ 3.10.4 The Contractor shall monitor the progress of the Work for conformance with the requirements of the Construction Schedule and shall promptly advise the Owner of any delays or potential delays. The Construction Schedule shall be updated to reflect actual conditions ("Progress Reports") (which updated schedule shall be subject to the approval of the Owner and the Architect) at appropriate intervals as determined by the Contractor and as required by the conditions of the Work and the Project (but in no event less frequently than weekly) or as otherwise requested by the Owner. In the event any Progress Report indicates any delays, the Contractor shall propose an affirmative plan to correct the delay, including overtime and/or additional labor, if necessary. In no event shall any Progress Report constitute an adjustment in the Contract Time, any Milestone Date or the Contract Sum unless any such adjustment is agreed to by the Owner and authorized pursuant to a Change Order.

§ 3.10.5 In the event the Owner determines that the performance of the Work as of a Milestone Date has not progressed or reached the level of completion required by the Contract Documents, the Owner shall have the right, but not the obligation, to order the Contractor to take corrective measures necessary to expedite the progress of construction, including, without limitation, (1) working additional shifts or overtime, (2) supplying additional manpower, equipment, and facilities, and (3) other similar measures (hereinafter referred to collectively as "Extraordinary Measures"). Such Extraordinary Measures shall continue until the progress of the Work complies with the stage of completion required by the Contract Documents. The Owner's right to require Extraordinary Measures is solely for the purposes of ensuring the Contractor's compliance with the accepted construction schedule as adjusted for time extensions granted pursuant to Section 8.3. Except as provided in Section 8.3, the Contractor shall not be entitled to an adjustment in the Contract Sum in connection with Extraordinary Measures required by the Owner pursuant to this Section 3.10.5. The Owner may exercise

the rights furnished the Owner under or pursuant to this Section 3.10.5 as frequently as the Owner deems necessary to ensure that that Contractor's performance of the Work will comply with any Milestone Date or the Substantial Completion Date, as the same may be extended by Change Order.

§ 3.10.6 The Owner shall have the right to direct a postponement or rescheduling of any date or time for the performance of any part of the Work that may interfere with the Owner's operations. Any postponement, rescheduling or performance of the Work under this Section 3.10.6 may be grounds for an extension of the Contract Time, if permitted under Section 8.3, and an equitable adjustment in the Contract Sum, to the extent permitted under the Contract Documents, if: (1) the performance of the Work was properly scheduled by the Contractor in compliance with the requirements of the Contract Documents and (2) such rescheduling or postponement is requested by or required for the convenience of the Owner. Without limiting the foregoing, the Contractor will not be entitled to an extension of the Contract Time or an adjustment of the Contract Sum to the extent the interfering Work so interferes as a result of the negligent act or omission of the Contractor or any Subcontractor or Sub-subcontractor or the failure of any of the same to perform the Work in a manner consistent with the Contract Documents, including Section 3.10.3 hereof.

§ 3.11 Documents and Samples at the Site

The Contractor shall make available, at the Project site, the Contract Documents, including a record set of Change Orders, Construction Change Directives, and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and the approved Shop Drawings, Product Data, Samples, and similar required submittals. The record set of documents shall reflect all deviations from the Drawings and Specifications and shall be updated in detail from time to time to reflect the actual progress of the Work. The Owner and the Architect shall have free and complete access to such documents during the construction of the Work. Upon Substantial Completion of the Work, the Contractor shall furnish to the Owner through the Architect one set of "as built" plans in such form as the Owner shall require. Such plans shall completely record all Work in place and serve as a record of the Work as constructed.

§ 3.12 Shop Drawings, Product Data and Samples

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

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

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

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

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

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents. Submittals shall be marked as reviewed by the Contractor for compliance with the Contract Documents and approved by the Contractor. Those that are not so marked may be returned by the Architect without action. The Contractor shall meet with the Architect in a timely fashion to discuss the schedule of submittals required under Section 3.10.2 and shall

thereafter timely prepare and submit for approval by the Architect a schedule of submittals for the Work. The Owner and Architect shall be entitled to rely upon the accuracy and completeness of all calculations and certifications required by the Contract Documents.

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

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

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

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

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

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

§ 3.13 Use of Site

§ 3.13.1 The Contractor shall confine operations at the site to areas permitted by applicable Legal Requirements and the Contract Documents, and shall not unreasonably encumber the site with materials or equipment.

§ 3.13.2 The Contractor shall locate, protect, and save from damage or disruption utilities and utility services lines of all kinds, either above or below grade found in the areas affected by the Work. The Contractor shall be responsible for all damage caused to such utilities by the operation of equipment or machinery, the delivery of materials, or as the direct or indirect result of any of the Work, and shall repair all such damage at its expense and as part of the Work included in the Contract Documents.

§ 3.13.3 The Contractor shall use only specifically assigned areas for parking, storage of materials, and construction operations, and such other areas as are authorized by the Owner. The Contractor shall comply with all Legal Requirements, including without limitation local municipal regulations, applicable to the use of and parking on public streets.

§ 3.13.4 The Contractor shall repair streets, drives, curbs, sidewalks, landscaping, and the other existing improvements at the site that are disturbed or damaged by the Contractor's construction operations, and restore the same to an equal condition as existed prior to any such disturbance or damage.

§ 3.13.5 The Contractor shall provide its own access to the existing building, and shall neither block nor interfere with the Owner's ordinary building operations, traffic, or parking facilities at the site, except as authorized in writing by the Owner.

§ 3.13.6 The Contractor shall be assigned, and shall use, a single point of access to the site of the Project, which shall be clearly posted with a Project sign approved by the Owner.

§ 3.13.7. Schedule for Contractor's Use of the Site.

§ 3.13.7.1 The Contractor shall perform construction of the Work on-site during the following hours: Monday through Friday, 7:00 a.m. through 3:30 p.m., EST. If school is in session at the Project site, the Contractor shall restrict Work activities to areas designated by the Owner, shall restrict deliveries and trucking to the building drive entrance to the Work area and laydown area designated by the Owner, and shall keep all public ways near the Project site clear of materials and traffic between the hours of 8:00a.m. through 8:30 a.m. to allow for student drop off, and 3:15p.m. through 3:45p.m. for student pick-up.

§ 3.13.7.2 The Contractor shall comply with all local noise ordinances in the performance of the Work.

§ 3.14 Cutting and Patching

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

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

§ 3.14.3 Unless authorized in writing by the Owner and the Architect, structural elements of the Work shall not be cut, patched, or otherwise altered or repaired. Existing work that is cut, damaged, disturbed, or otherwise interfered with by the Contractor, a Subcontractor, or anyone for whom any of them is responsible shall be fully, properly and carefully repaired by the responsible Contractor or Subcontractor. All such repairs shall be completed to the satisfaction of the Architect, and shall match similar existing adjoining work.

§ 3.14.4 The Contractor shall install all required sleeves and inserts for any built-in building component required for the Work, and shall not cut any existing finished materials or structural elements at the site unless and until the Contractor submits appropriate detail drawings to the Architect and Owner, and the Architect and Owner provide their written approval. Cutting and patching of all building elements caused by failure to provide or properly locate sleeves, forms and inserts, incorrect location of work or failure to cooperate with other trades, shall be performed by the Contractor at no additional cost to the Owner. Such repair work shall be carried out by mechanics skilled in the repair trade concerned, with due regard to trade practices, and with suitable protection of existing Work, all at no cost to the Owner.

§ 3.15 Cleaning Up

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

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

§ 3.15.3 The Contractor shall remove all stains, spots, marks, debris and dirt resulting from construction operations from all surfaces of the existing building, and shall clean the entire site and Project grounds upon completion of the Work to the satisfaction of the Owner.

§ 3.16 Access to Work

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

§ 3.17 Royalties, Patents and Copyrights

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights, or failure to pay such royalty and license fees, and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Architect. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Architect.

§ 3.18 Indemnification

§ 3.18.1 To the fullest extent permitted by law, the Contractor shall indemnify, defend and hold harmless the Owner, the Owner's designated representative, the Architect, the Architect's consultants, and all of their respective directors, members of governing boards, officials, officers, partners, employees, shareholders, members, managers, beneficiaries, agents and representatives (each an "Indemnitee") from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, but only to the extent caused by the negligent acts or omissions, violations of Legal Requirements, or breach of contract by the Contractor, a Subcontractor, Sub-subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable. The obligations of the Contractor under the foregoing indemnity shall include, without limitation, to the fullest extent permitted by law, any and all claims (including attorneys' fees resulting therefrom) directly or indirectly arising or alleged to arise (1) out of the performance of or the failure to perform the Work, or the condition of the Work, the job site, adjoining land or driveways, or streets or alleys used in connection with the performance of the Work, and from any and all claims by workmen, suppliers or Subcontractors who are involved in the performance of the Work, and (2) under any scaffolding, structural work or safe place law or any law with respect to the protection of adjacent landowners. These indemnification obligations are not intended to include liability for damage arising out of bodily injury to person or damage to property to the extent caused by or resulting from the negligence of the indemnitee, such indemnitee's agents or employees, nor shall such obligations be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

§ 3.18.2 In claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, a Sub-subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages, compensation, or benefits payable by or for the Contractor or a Subcontractor or a Sub-subcontractor under workers' compensation acts, disability benefit acts, or other employee benefit acts.

§ 3.18.3 To the fullest extent permitted by law, the Contractor shall further indemnify, defend and hold harmless each Indemnitee from and against (1) all claims for payment by any Subcontractor or supplier of any tier, (2) any and all actions, lawsuits, claims and proceedings brought against the Indemnitee as a result of liens filed against the Work, the Project site or any improvements thereon (referred to collectively as "Liens") by the Contractor, any Subcontractor, Sub-subcontractor or anyone claiming by, through or under them, and (3) all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any Lien, claim or other claim for payment by any Subcontractor or supplier of any tier. The Contractor shall pay any judgment or Lien resulting from any such actions, lawsuits, or proceedings. Upon receipt of notice of a Lien claim or other claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the Lien or other claim for payment has been asserted. The Contractor's obligations under this Section 3.18.3 are conditioned upon Owner having fulfilled its payment obligations to the Contractor with respect to the Work that is the subject of the Lien or claim and for which indemnification is sought.

§ 3.18.4 The Contractor shall bear any and all reasonable expenses incurred by any Indemnitee because of any claim or other matter indemnified against under this Section 3.18, including without limitation, attorneys' and consultants' fees and expenses, court costs, and costs related to the defense of, or preparing for the defense against, any such claim. If any such claim has not been settled or discharged or bonded at the time of final completion of the Work, and if such claim is not covered in full by a policy of insurance then in effect from a reputable and financially sound insurance company which has not declined or reserved the right to decline coverage of such claim, the Owner may withhold an amount equal to two hundred percent (200%) of the outstanding claim until any such claim is paid or settled or the Contractor provides a bond, acceptable to the Owner, to satisfy such claim.

§ 3.19 Meetings

§ 3.19.1 A qualified representative of the Contractor shall attend periodic progress meetings held at such time and as such place as the Architect or the Owner shall designate.

§ 3.19.2 The Contractor shall schedule and conduct progress meetings at the Project site on a weekly basis. Attendance is required of each Subcontractor, supplier, or other entity whose portion of the Work is currently the subject of concern or discussion or planning of future construction activities. Contractor shall provide the Owner and Architect with forty-eight (48) hours prior notice of each such progress meeting and be permitted to attend and participate in the meetings.

ARTICLE 4 ARCHITECT

§ 4.1 General

§ 4.1.1 The Architect is the person or entity retained by the Owner pursuant to Section 2.3.2 and identified as such in the Agreement.

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

§ 4.2 Administration of the Contract

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

§ 4.2.2 The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that such portion of the Work is, and when the Work is fully completed the entirety of the Work will be, in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences, or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents. The Owner may elect to have an observer, in addition to the Architect, present during the Work, who will record and report to the Owner any deviation in the Work from the requirements of the Contract Documents, and the progress of the Work. The observer shall have no authority to act on behalf of the Owner with respect to the Contract or Project, and no authority to change the Work or the requirements of the Contract Documents, to direct the Work, suspend the Work, or approve Submittals or Shop Drawings.

§ 4.2.3 On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and promptly report to the Owner (1) known deviations from the Contract Documents, (2) known deviations from the most recent construction schedule submitted by the Contractor, and (3) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of, and will not be responsible for acts or omissions of, the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ 4.2.4 Communications

The Owner and Contractor shall include the Architect in all communications that relate to or affect the Architect's services

or professional responsibilities. The Owner shall promptly notify the Architect of the substance of any direct communications between the Owner and the Contractor otherwise relating to the Project. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner. The Contract Documents may specify other communication protocols.

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

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

§ 4.2.7 The Architect will review and comment, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5, and 3.12. The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

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

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

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

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

§ 4.2.12 Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such interpretations and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either, and will not be liable for results of interpretations or decisions rendered in good faith.

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

§ 4.2.14 The Architect will review and respond to requests for information about the Contract Documents. The Architect's

response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ 5.1 Definitions

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term “Subcontractor” is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term “Subcontractor” does not include a Separate Contractor or the subcontractors of a Separate Contractor.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site and, unless expressly provided otherwise, refers to subcontractors or any and all tiers other than Subcontractors. The term “Sub-subcontractor” is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

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

§ 5.2.1 Unless otherwise stated in the Contract Documents, the Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the persons or entities proposed for each principal portion of the Work, including those who are to furnish materials or equipment fabricated to a special design plus such other information as required under the Agreement. Unless otherwise provided in the Agreement, within 14 days of receipt of the information, the Architect may notify the Contractor whether the Owner or the Architect (1) has reasonable objection to any such proposed person or entity or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 5.2.1.1 The Contractor shall solicit bids for the performance of the Work from, and award subcontracts to, Subcontractors all in accordance with the requirements set forth in the Agreement and in compliance with applicable Legal Requirements.

§ 5.2.1.2 If requested by the Owner, the Contractor shall provide to the Owner copies of all Subcontracts and supply agreements entered into by the Contractor for the Work.

§ 5.2.2 The Contractor shall not enter into any subcontract with a proposed person or entity for such person or entity to perform any of the Contractor’s obligations under the Contract, for whom the Owner has not provided its express prior written approval.

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

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person, or entity for one previously selected if the Owner or Architect makes reasonable objection to such substitution. If the Contractor wishes to substitute a different person or entity for a person or entity previously selected and approved as a Subcontractor pursuant to this Section 5.2, the procedure set forth in this Section 5.2 and as may be provided in the Agreement shall be followed.

§ 5.3 Subcontractual Relations

Any part of the Work performed by a Subcontractor shall be pursuant to a written Subcontract between the Contractor and Subcontractor, which form of Subcontract shall be reasonably satisfactory to the Owner in all respects. Copies of all Subcontractor bids or proposals shall, upon request of Owner, be submitted to the Owner and Architect. All Subcontracts shall provide that each Subcontractor, to the extent of the Work to be performed by the Subcontractor, be bound to the Contractor by the terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor’s Work that the Contractor, by these Contract Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of

the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 Contingent Assignment of Subcontracts

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

- .1 assignment is effective only after termination of the Contract by the Owner pursuant to and in accordance with Section 14 of these General Conditions and only for those Subcontract and supply agreements that the Owner accepts by notifying the Subcontractor or supplier and the Contractor; and
- .2 assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the Subcontract to the extent such rights and obligations arise subsequent to Owner's acceptance of the assignment. The Contractor agrees to execute any and all other documents required to effect this assignment.

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 60 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

§ 5.4.3 Upon assignment to the Owner under this Section 5.4, the Owner may further assign the Subcontract and/or supply agreement to a successor contractor or other entity.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

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

§ 6.1.1 The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the contract documents comprising each such separate contract shall, in each case, mean the contractor who executes each separate contract with the Owner.

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

§ 6.1.4 Intentionally omitted.

§ 6.2 Mutual Responsibility

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

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

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

§ 6.2.3 The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a Separate Contractor because of the Contractor's delays, disruption of the work of such Separate Contractor, improperly timed activities or defective construction. The Owner shall have the right to off-set such costs against any amounts owed to the Contractor by the Owner. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a Separate Contractor's delays, Separate Contractor's disruption of the Work, improperly timed activities, damage to the Work or defective construction provided that the Contractor promptly notifies the Owner of such delays, disruption, activities, damage or defective construction.

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

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

§ 6.2.6 Upon the Owner's request, the Contractor shall defend any proceedings brought against the Owner by any Separate Contractor on account of any damage alleged to have been caused by the Contractor which arises from the Contractor's failure to comply with the terms and conditions of Sections 6.1 and 6.2.

§ 6.3 Owner's Right to Clean Up

Upon written notification from the Architect that the project requires cleaning, the Contractor shall within 24 hours remove all rubbish and hazards from the project and shall arrange his material and equipment in an orderly manner on the site. If this cleaning is not completed within 24 hours, the Owner may engage labor to clean up the project to his satisfaction and deduct the costs from any monies due the Contractor. If a dispute arises among the Contractor, Separate Contractors, and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and the Architect will allocate the cost among those responsible, as the Architect deems appropriate in its sole discretion.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 General

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

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

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

§ 7.1.4 In the case of a change in the Work proposed by the Owner or a proposed Change Order submitted by the Contractor, upon the request of the Owner or the Architect (with the Owner's approval), the Contractor shall submit to the Architect, in such form as the Architect may require, an accurate written estimate of the cost of any proposed extra Work or change in the Work. Such estimates shall be provided without cost to the Owner. The Contractor's estimate shall indicate the description, quantity, and unit cost of each item of material, and the number of hours of work and hourly rate for each class of labor, as well as all other costs chargeable under the terms of this Article 7. Unit labor costs for the installation of each item of materials shall be provided if required by the Architect. The Contractor shall promptly revise and resubmit such estimate if the Architect determines that it is not in compliance with the requirements of this Section

7.1.4, or that it contains errors of fact or mathematical errors. If required by the Architect, in order to establish the exact cost of new Work added or of previously required Work omitted, the Contractor shall obtain and furnish to the Architect bona fide proposals from recognized suppliers for furnishing any material included in such Work. Such estimates shall be furnished promptly so as to occasion no delay in the Work. The Contractor shall also state in the estimate any change in the Contract Time that would result from the change or extra work.

§ 7.2 Change Orders

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

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

§ 7.2.2 A Change Order executed by the Owner and the Contractor shall constitute a final settlement of all matters relating to the subject matter of the Change Order including, without limitation, compensation to be paid to the Contractor in connection with any change in the Work required by the Change Order (provided that the Work that is the subject of such change is performed in a manner consistent with the provisions of the Contract Documents and the applicable Change Order), including but not limited to all direct and indirect costs, profit, overhead, extended overhead, loss of productivity and general conditions associated with such change, and any and all adjustments to the Contract Sum, the Construction Schedule, and to the Contract Time. In the event a Change Order affects an increase in the Contract Sum, Contractor shall include the work covered by such the Change Order in Applications for Payment for such work as if the work were originally part of the Work as set forth in the Contract Documents.

§ 7.2.3 Notwithstanding anything to the contrary set forth in these General Conditions, if the Agreement sets forth the methodology for calculating adjustments in the Contract Sum associated with a change in the Work, and if, under the terms of the Contract Documents, an adjustment in the Contract Sum would be required, then the adjustment will be based on such methodology unless otherwise mutually agreed by the parties. This paragraph shall be applicable in the case of a change in the Work effected by a Change Order as well as a Construction Change Directive.

§ 7.2.4 Unless otherwise instructed by the Owner, Change Orders shall be prepared on the form AIA G-701.

§ 7.3 Construction Change Directives

§ 7.3.1 A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

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

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

- (i) Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- (ii) Unit prices stated in the Contract Documents or subsequently agreed upon;
- (iii) Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- (iv) As provided in Section 7.3.4.

§ 7.3.3.1 Notwithstanding anything to the contrary contained in the foregoing provisions of this Section 7.3, in the case of a change in the Work for which the Contractor is entitled to an adjustment in the Contract Sum under the terms and conditions of the Contract Documents, such adjustment shall be limited as follows:

- (i) For that portion of the change in the Work that is self-performed by the Contractor, the Contractor's overhead and profit on such Work shall not exceed ten percent (10%) of the net increase in the Contractor's direct costs incurred in the performance of such Work;
- (ii) For that portion of the change in the Work that is performed by Subcontractors, the Contractor's markup for

overhead and profit on such subcontracted Work shall not exceed five percent (5%) of the amount invoiced to the Contractor by the Subcontractors for that Work;

- (iii) For that portion of the change in the Work that is performed by a first-tier Subcontractor, that Subcontractor's overhead and profit on its portion of the change in the Work shall not exceed ten percent (10%) of the net increase in the Subcontractor's costs incurred in the performance of such Work directly by such Subcontractor
- (iv) For that portion of the change in the Work that is performed by a first-tier Subcontractor, that Subcontractor's markup for overhead and profit on its portion of the Change in the Work shall not exceed five percent (5%) of the amount invoiced to that Subcontractor by Sub-subcontractors or suppliers for that Work; and
- (v) The aggregate markup of Contractor, Subcontractors and Sub-subcontractors in connection with any change in the Work shall not exceed fifteen percent (15%) of the net increase in the Cost of the Work for labor, materials and/or equipment arising from such change.

These limitations set forth in this Section 7.3.3.1 shall apply to both additions to and deductions from the Contract Sum.

For change order Work that is the subject of Unit Prices under the Contract Documents, there will be no markup permitted on the applicable Unit Prices.

The Contractor shall include the markup limitations set forth in this Section 7.3.3.1 in all Subcontracts and require in all Subcontracts that the Subcontractors include such limitations in all lower tier Subcontracts.

§ 7.3.3.2 All Change Orders and Construction Change Directives shall provide itemized accounting that provides a detailed break-out of all materials and labor rates applicable thereto, including:

- (i) Costs of labor, including social security, old age and unemployment insurance, fringe benefits required by agreement or custom, and workers' compensation insurance;
- (ii) Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;
- (iii) Fair market rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others provided, if rented from the Contractor, such rental and the rental rates have been approved by the Owner;
- (iv) Costs of premiums for all bonds and insurance, permit fees, and sales, use or similar taxes related to the Work;
- (v) Additional costs of supervision and field office personnel directly attributable to the change to the extent permitted under the Contract Documents.

§ 7.3.3.3 The costs described in Section 7.3.3.2 shall not include any of the following:

- (i) Salaries and other compensation of the Contractor's personnel stationed at the Contractor's principal office or offices other than the site office, except as specifically approved by the Owner;
- (ii) Expenses of the Contractor's principal office and offices other than the site office;
- (iii) Overhead and general expenses, except as may be expressly included in Section 7.3.3.1;
- (iv) The Contractor's capital expenses, including interest on the Contractor's capital employed for the Work;
- (v) Costs due to the negligence or failure of the Contractor, Subcontractors and suppliers or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable to fulfill a specific responsibility of the Contract Documents; or
- (vi) Any cost not described in Section 7.3.3.2.

§ 7.3.4 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement and subject to the limitations set forth in Section 7.3.3.1. In such case, and also under Section 7.3.3(iii), the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.4 shall be limited to the following:

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

- .2 Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;
- .3 Rental costs (not to exceed fair market rental costs) of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others provided, if rented from the Contractor, such rental and the rental rates have been approved by the Owner;
- .4 Costs of premiums for all bonds and insurance, permit fees, and sales, use, or similar taxes, directly related to the change; and
- .5 Costs of supervision and field office personnel directly attributable to the change to the extent permitted under the Contract Documents.

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

§ 7.3.6 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and, prior to proceeding with such Work, advise the Architect of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

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

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

§ 7.3.9 Pending final determination of the total cost to the Owner of a Construction Change Directive, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Architect will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment actual costs incurred by the Contractor in the performance of the work under a Construction Change Directive which are substantiated to the reasonable satisfaction of the Architect; provided that such costs are of the type included in the Cost of the Work as described in the Contract Documents and such Construction Change Directive is not made necessary by the negligent act or omission of the Contractor, a Subcontractor or anyone for whom any of them is responsible. This interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

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

§ 7.4 Minor Changes in the Work

The Architect may order minor changes in the Work that are consistent with the intent of the Contract Documents and do not involve an adjustment in the Contract Sum or an extension of the Contract Time. The Architect's order for minor changes shall be in writing. If the Contractor believes that the proposed minor change in the Work will affect the Contract Sum or Contract Time, the Contractor shall notify the Architect and shall not proceed to implement the change in the Work. If the Contractor performs the Work set forth in the Architect's order for a minor change without prior notice to the Architect that such change will affect the Contract Sum or Contract Time, the Contractor waives any adjustment to the Contract Sum or extension of the Contract Time.

ARTICLE 8 TIME

§ 8.1 Definitions

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

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

§ 8.1.3 The date of Substantial Completion is the date Substantial Completion is achieved as provided in Section 9.8.1.

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

§ 8.2 Progress and Completion

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work and that the Contractor is capable of completing the Work within the Contract Time.

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

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion of the Work in accordance with the Contract Documents within the Contract Time.

§ 8.3 Delays and Extensions of Time

§ 8.3.1 If the Contractor is delayed at any time in the commencement or progress of the Work by (1) an act or neglect of the Owner or Architect, of an employee of either, or of a Separate Contractor; (2) changes ordered in the Work by the Owner, which changes were not necessitated by the fault of the Contractor, a Subcontractor, a Sub-subcontractor, a material or equipment supplier or anyone for whom any of them is responsible; (3) area-wide labor disputes not directed at the Contractor or any of its Subcontractors, or by illegal labor actions or disputes; (4) fire, unusual and unanticipated delay in deliveries, unavoidable casualties, abnormally adverse weather conditions documented in accordance with Section 15.1.6.2, or other causes beyond the Contractor’s control; (5) delay authorized by the Owner pending mediation and binding dispute resolution; or (6) other causes that the Contractor asserts, and the Architect determines, justify delay, then the Contract Time shall be extended by Change Order for such reasonable time as the Architect may determine; provided that (i) any such delay has the effect of delaying completion of components of the Work on any critical path indicated in the Construction Schedule, (ii) any such delay is not caused by, or could not have been avoided by the exercise of reasonable efforts of the Contractor, (iii) any such delay could not be limited or avoided by the Contractor’s timely notice to the Owner of the delay, and (iv) such delay has an impact of at least one (1) day.

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

§ 8.3.3 **No Damage For Delay.** Notwithstanding anything to the contrary set forth in the Contract Documents, the Owner shall not be liable to the Contractor or any Subcontractor for Claims or damages of any nature caused by or arising out of delays. The sole remedy against the Owner for delays shall be the allowance of additional time for completion of the Work, the amount of which shall be subject to the procedures set forth in the Contract Documents. Except to the extent, if any, expressly prohibited by law, the Contractor expressly agrees not to make and hereby waives any Claim for damages for any delay, including, but not limited to, those resulting from increased labor or material costs; directions given or not given by the Owner or Architect, including scheduling and coordination of the Work; the Architect’s preparation of drawings and specifications or review of shop drawings and requests for instruction(s); or, on account of any delay, obstruction or hindrance for any cause whatsoever by the Owner, Architect, or any other contractor on the Project, whether or not foreseeable or anticipated. The Contractor agrees that its sole right and remedy therefore shall be an extension of the Contract Time, if appropriate.

§ 8.3.4 It is expressly understood that notwithstanding anything to the contrary set forth in the Contract Documents, no Subcontractor shall be entitled to make any Claim for additional compensation, costs or damages against the Contractor (nor may the Contractor assert against Owner such Claims as pass-through claims of Subcontractor or otherwise) for delay. Unless agreed by Owner in writing, Contractor shall include in every Subcontract a ‘No-Damage-For-Delay’ provision in a form reasonably approved by the Owner.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

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

§ 9.1.2 Intentionally omitted.

§ 9.2 Schedule of Values

The Contractor shall submit a schedule of values to the Architect before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect. This schedule, upon the approval thereof by the Owner and the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and supported by such data to substantiate its accuracy as the Architect may require, and unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

§ 9.3 Applications for Payment

§ 9.3.1.1 Not later than fifteen (15) calendar days before the date established for submission of a final version of an Application for Payment pursuant to the Agreement, the Contractor shall submit to the Architect and the Owner for review and consideration a draft itemized Application for Payment prepared in accordance with the Contract Documents and the Schedule of Values for portions of the Work completed and projected to be completed during such month. The draft Application shall be submitted along with all data, information and documentation substantiating the Contractor's right to payment as required under the Contract Documents and as may otherwise be required by the Owner or Architect (collectively, the "Supporting Documentation"). Within five (5) days of the Contractor's submission of a draft Application for Payment, the Architect and Owner shall notify the Contractor of any necessary changes to be included in the Contractor's final version of the Application for Payment. Subsequent to the Architect's and the Owner's review and comment, the Contractor shall make all necessary changes to the draft Application for Payment and resubmit a final version of the Application for Payment to the Architect and the Owner for payment as provided in Section 9.3.1 and Article 5 of the Agreement.

§ 9.3.1.2 "Supporting Documentation" may include, without limitation, payrolls, petty cash accounts, receipted invoices or invoices with check vouchers attached, releases and waivers of liens and claims from the Contractor, Subcontractors, Sub-subcontractors and suppliers, and other evidence required by the Owner or Architect to demonstrate that cash disbursements already made by the Contractor to others on account of the Contractor's cost of performing the Work equal or exceed progress payments already received by the Contractor.

§ 9.3.1.3 No later than the fifth (5th) business day of each month, the Contractor shall submit to the Architect an itemized final version of an Application for Payment prepared in accordance with the Schedule of Values for portions of the Work completed during the preceding month, inclusive of the value of materials delivered and suitably stored at the Project site during the month covered by such Application for Payment. The Application for Payment shall be notarized, if required, and supported by all data substantiating the Contractor's right to payment that the Owner or Architect require, such as copies of requisitions, and releases and waivers of claims and liens from Subcontractors, Sub-subcontractors, and suppliers, and shall reflect retainage as provided for in the Contract Documents. Within five (5) days of submission of the final version of the Application for Payment and Supporting Documentation, the Architect shall approve or deny the Application for Payment as described by Section 9.4.1 below. Within thirty (30) days of Contractor's submission of a final version of an Application for Payment and Supporting Documentation, the Owner shall make payment to the Contractor of the amount certified by the Architect in a Certificate for Payment to be paid to the Contractor.

§ 9.3.1.4 Applications for Payment shall reflect retainage as provided for in the Contract Documents.

§ 9.3.1.5 As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders.

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

§ 9.3.2 Unless otherwise provided in the Contract Documents or prohibited by an Agency (as defined in the Agreement) or any person or entity providing funding for the Project, payments shall be made on account of materials and equipment

delivered and suitably stored at the site for subsequent incorporation in the Work. The Contractor shall protect such stored materials and equipment from fire, theft, vandalism, weather and other damage and such items shall be available at all times for inspection by the Owner and the Architect. If approved in advance by the Owner, and not prohibited by an Agency or any person or entity providing funding for the Project, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance (which insurance shall include coverage naming the Owner and such others as may be identified by the Owner from time to time, if any, as additional insureds, and which shall specify and relate to the address where the stored materials and equipment are located including, if applicable, the Project site), storage, and transportation to the site, for such materials and equipment stored off the site. The Contractor shall be responsible for protection of all such materials from loss or damage, at no additional cost to the Owner, until such materials are incorporated into the Work on-site, whether or not paid for by the Owner.

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

§ 9.3.3.1 Commencing with the second Application for Payment, and continuing with each Application for Payment submitted thereafter, the Contractor shall furnish to the Owner a properly executed release and waiver of claims in a form acceptable to the Owner, from the Contractor and each Subcontractor and material supplier whose Work was included on the previous Application for Payment for which payment by Owner was made to the Contractor. In addition to the foregoing, if requested by the Owner, commencing with the first Application for Payment and continuing with each Application for Payment submitted thereafter, the Contractor shall also provide a properly executed conditional release and waiver of claims in form acceptable to the Owner from the Contractor and each Subcontractor and material or equipment supplier whose Work is included on the Application for Payment subject only to receipt of payment under such Application for Payment.

§ 9.3.4 Unless otherwise required by the Owner, Applications for Payment shall be on AIA Documents G702 and G703.

§ 9.4 Certificates for Payment

§ 9.4.1 The Architect will, within ten (10) days after receipt of the final version of Contractor's Application for Payment and Supporting Documentation submitted therewith, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Architect determines is properly due, and notify the Contractor and Owner of the Architect's reasons for withholding certification in part as provided in Section 9.5.1; or (3) withhold certification of the entire Application for Payment, and notify the Contractor and Owner of the Architect's reason for withholding certification in whole as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data in the Application for Payment and Supporting Documentation submitted therewith, that, to the best of the Architect's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the Architect. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ 9.5 Decisions to Withhold Certification

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

- .1 defective Work not remedied;
- .2 third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;
- .3 failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials, or equipment, in accordance with the provisions of the Contract Documents and the applicable agreement between the Contractor and the Subcontractor or supplier with respect to the Project and/or the Work;
- .4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- .5 damage to the Owner or a Separate Contractor;
- .6 reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay;
- .7 repeated failure to carry out the Work in accordance with the Contract Documents;
- .8 amounts previously paid to the Contractor are in excess of amounts properly due the Contractor; or
- .9 failure of the Contractor to comply with any of the Contractor's indemnification obligations under the Contract Documents.

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

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

§ 9.5.4 If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. Upon request by the Owner, the Contractor shall properly endorse such joint checks to enable the deposit thereof by the other payee. If the Owner makes payments by joint check, the Owner shall notify the Architect and such payments shall be reflected on the Contractor's subsequent Applications for Payment as payments received by the Contractor.

§ 9.6 Progress Payments

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

§ 9.6.2 The Contractor shall use payments made under the Contract solely for the purpose of performance of the Work pursuant to the Contract Documents. Contractor shall pay for all labor and services performed and materials, equipment and machinery supplied by others in connection with the performance of the Work, in accordance with the Contract Documents and as required by applicable Legal Requirements.

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

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

§ 9.6.5 The Contractor's payments to suppliers shall be treated in a manner similar to that, and subject to the same requirements as are, provided in Sections 9.6.2, 9.6.3 and 9.6.4.

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

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

§ 9.6.8 Any provision in the Contract Documents to the contrary notwithstanding, the Owner shall not be obligated to make payment to the Contractor hereunder to the extent that the Contractor has not performed the Work or supplied the materials, for which payment is requested, in accordance with the Contract Documents.

§ 9.7 Failure of Payment

If the Architect does not issue a Certificate for Payment in accordance with the requirements of the Contract Documents, through no fault of the Contractor, within ten (10) days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within ten (10) days after the date such payment is due to be paid by the Owner pursuant to the terms of the Contract Documents, the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon ten (10) additional days' notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's actual reasonable additional costs incurred as a result of shutdown and start-up.

§ 9.8 Substantial Completion

§ 9.8.1 The Work shall be considered to be "Substantially Complete(d)" or to have reached "Substantial Completion" on the date as determined by the Architect when (1) the entirety of the Work is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for the use for which it is intended (subject only items on the Punchlist, the completion of which can be accomplished within thirty (30) days without interfering with the actual use of the Work by the Owner or those claiming by, through or under the Owner), (2) the Contractor has obtained a temporary or permanent certificate of occupancy for the Work permitting the lawful occupancy of the entire Project or such other permits, approvals, licenses, and other documents, for which the Contractor is responsible, from any governmental authority having jurisdiction thereof which are necessary for the beneficial occupancy and use of the Project site and building, and (3) the Architect has issued a Certificate of Substantial Completion for the entirety of the Work pursuant to Section 9.8.4 of these General Conditions.

Without limitation of the foregoing, Substantial Completion of the Work shall not be deemed to have occurred until construction and installation of all facilities and systems (including but not limited to instrumentation and controls) are complete in all respects as required for the issuance of all required use and occupancy permits and approvals by all Agencies and applicable governmental authorities. Further, if and to the extent applicable given the Work required to be performed under the Contract Documents, Substantial Completion shall require commissioning systems, including but not limited to testing of individual system components and equipment and full operational startup and certification testing, as necessary to obtain all required use and occupancy permits and approvals by all Agencies and applicable governmental authorities.

Contractor shall prepare all documentation required by the Owner and any Agencies, including without limitation the State of Connecticut Department of Administrative Services ("DAS") in connection with grant(s) or other financial assistance by the State of Connecticut to the Owner for the Project and compliance with State audit requirements applicable to the Project and/or any such grants, the Connecticut Commission on Human Rights and Opportunities ("CHRO"), and the Connecticut Department of Energy and Environmental Protection ("CTDEEP").

§ 9.8.2 When the Contractor considers that the Work is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected prior to final payment (the “Punchlist”). Failure to include an item on the Punchlist does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

§ 9.8.3 Upon receipt of the Contractor’s Punchlist, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect’s inspection discloses any item, whether or not included on the Contractor’s list, which is not sufficiently complete in accordance with the Contract Documents as described in Section 9.8.1(1), the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

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

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate.

§ 9.9 Partial Occupancy or Use

§ 9.9.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit the Punchlist to the Architect as provided under Section 9.8.2 and 9.8.3. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect. The facility may be occupied and open to normal use during part or all of the construction of the Work. Such normal usage of the facility shall in no way affect the insurance coverages required pursuant to the Contract Documents, including without limitation Article 11.

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

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

§ 9.10 Final Completion and Final Payment

§ 9.10.1 Upon receipt of the Contractor’s notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect and the Owner will promptly make such inspection. When the Architect and the Owner find the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect’s knowledge, information and belief, and on the basis of the Architect’s and the Owner’s on-site visits and inspections, the Work has been completed in accordance with the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect’s final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor’s being entitled to final payment have been fulfilled. All warranties and guarantees required under or pursuant to the Contract Documents not previously delivered shall be assembled and delivered by the Contractor to the Owner and Architect as part of the final Application for Payment. The final Certificate for Payment will not be issued by the Architect until all warranties and guarantees and all other close-out

deliverables (including those set forth in Section 9.10.2 below) have been received and accepted by the Owner.

§ 9.10.2 The Contractor shall be required to submit the following to the Owner and the Architect, in the form satisfactory to the Owner, as conditions to the issuance of a final Certificate for Payment and delivery of final payment:

- (1) an affidavit and waiver of claims attesting that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied;
- (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect, which shall include, without limitation product liability and completed operations, for the six (6) year period following final completion and evidence that such insurance will not be canceled or allowed to expire;
- (3) a written statement that the Contractor knows of no reason that the insurance will not be renewable to cover the period required by the Contract Documents;
- (4) consent of surety to final payment, on AIA Document G706 or G707;
- (5) final prints for record drawing use marked by the Contractor with record information as set forth in the Contract Documents;
- (6) all guarantees and warranties to which the Owner is entitled hereunder including documentation of any special warranties, such as manufacturers' warranties or specific Subcontractor warranties, including without limitation, the Contractor's guarantee that for no less than two (2) years after the date of Substantial Completion the Contractor shall correct and/or replace all defective workmanship, supplies, and/or materials included in the Work to the satisfaction of the Owner;
- (7) a final sworn statement from the Contractor duly executed and acknowledged showing all Subcontractors to be fully paid and similar sworn statements from Subcontractors and, where appropriate, from Sub-subcontractors;
- (8) satisfactory proof that all claims, including taxes (if any), arising out of the Work (including any claims of Subcontractors or suppliers) have been released or bonded and other data establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the Contract signed by each Subcontractor, Sub-subcontractor and material supplier who performed or provided Work or materials under the Contract Documents and conditioned only upon receipt of final payment, the amount of which is consistent with the final Application for Payment, all to the extent and in such form as may be designated by the Owner;
- (9) final documents of similar nature to those required by the Contract Documents for any monthly payments hereunder;
- (10) all final permits, approvals (including, without limitation, the approval of the Owner's insurance company, if required and requested in a timely fashion) certificates (including, without limitation, certificates in respect of electrical systems and life safety systems) and authorizations for use and occupancy of the Project required by any authority having jurisdiction, including any building permits, temporary and unconditioned permanent and full certificate of occupancy and any other necessary occupancy and use permits;
- (11) formally prepared "as built" drawings, records and related data including all field notes of all the Work (such drawings shall be in the form of "mylar" reproducible drawings, or as otherwise called for in the Contract Documents);
- (12) the Operating and Maintenance Manual for the Project as provided below;
- (13) a final statement of accounting for all allowances in form satisfactory to the Owner and/or DAS; and
- (14) delivery of all spare parts required to be submitted pursuant to the Contract Documents.

§ 9.10.2.1 The "Operating and Maintenance Manual" for the Project shall be defined in the Contract Documents. Except as required otherwise by the Contract Documents, the "Operating and Maintenance Manual" for the Project shall contain, as applicable to the Work, (1) full information for each item of mechanical, electrical, or other operating equipment, copies of warranties therefor, schematic diagrams of control systems, circuit directories for each electric and communications panel board, and charts showing the tagging of all valves; and (2) complete keying schedules, paint color schedules, and paint color samples. Each volume of the manual shall be clearly indexed, and shall include a directory of all Subcontractors and maintenance contractors, indicating the area of responsibility of each, and the name and telephone number of the responsible member of each organization. The volumes shall be in both electronic and in bound book form.

§ 9.10.2.2 If a Subcontractor, Sub-subcontractor or supplier refuses to furnish a release or waiver required by the Owner,

the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien, claim, security interest, or encumbrance. If no such bond is provided, the Owner may, without limiting its remedies under law, in equity, or under the Contract Documents, withhold the portion of final payment claimed to be due by the relevant Subcontractor, Sub-subcontractor or supplier until such lien, claim, security interest, or encumbrance is resolved. The Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging or otherwise resolving such lien, claim, security interest, or encumbrance, including all costs and reasonable attorneys' fees.

§ 9.10.2.3 If the final documentation submitted by the Contractor is not deemed complete by the Owner or if the Owner deems the Work incomplete in any respect, the Contractor shall promptly complete any such Work and shall promptly resubmit the final documentation.

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

§ 9.10.4 Intentionally omitted.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor, Sub-subcontractor, or a supplier, shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs required by the applicable Legal Requirements, the Contract Documents or as reasonably requested by the Owner in connection with the performance of the Contract. The Contractor shall monitor all job site safety and promptly report deficiencies to responsible Subcontractors and to the Owner.

§ 10.2 Safety of Persons and Property

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

- .1 employees on the Work and other persons who may be affected thereby;
- .2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and
- .3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

§ 10.2.2 The Contractor shall comply with, and give notices required by the Legal Requirements, bearing on safety of persons or property or their protection from damage, injury, or loss, including without limitation of Connecticut General Statutes Section 31-40m relating to toxic substances, the requirements of the Occupational Safety and Health Act and the Construction Safety Act of 1969, as amended, and regulations and standards promulgated thereunder, and/or ordinances, rules, regulations and lawful orders of governmental authorities bearing on safety of persons or property or the environment or their protection from damage, injury, destruction, pollution or loss. The Contractor shall be directly responsible for compliance therewith on the part of its agents, employees, materialmen and Subcontractors and suppliers, and Sub-subcontractors, and shall directly receive and be responsible for all citations, assessments, fines or penalties which may be incurred by reason of the failure of the Contractor's agents, employees, Subcontractors or suppliers, or of any Sub-subcontractor, to so comply.

§ 10.2.3 The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against

hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards. The Contractor shall also be responsible for all measures necessary to protect any property adjacent to the Project and improvements thereon. Any damage to such property or improvements shall be promptly repaired by the Contractor at its cost and expense.

§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall obtain all necessary permits from regulating agencies, exercise utmost care, and carry on such activities under supervision of properly qualified personnel, and strictly and fully comply with all applicable Legal Requirements relating to the storage or use explosives or other hazardous materials or equipment.

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

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

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

§ 10.2.8 Injury or Damage to Person or Property

If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, notice of the injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding ten days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter. The Contractor shall protect and maintain in operation all existing pipelines, conduits, sewers, drains, poles, wiring and similar conditions at the site which are within the area for construction of the Work, whether or not specifically shown on the Drawings. The Contractor shall ensure that all such items are protected, supported and/or moved as necessary for performance of the Work.

§ 10.2.9 In the event the Contractor identifies activities or conditions during performance of the Work or at the Project, which, in the Contractor's good faith opinion, pose an unreasonable risk of bodily injury or property damage, whether immediate or in the future, the Contractor shall have the right to immediately take steps to protect its personnel and Subcontractors and stop Work and remove its personnel from the affected area.

§ 10.2.10 The Contractor shall at all times provide protection against weather (rain, wind, storms or heat) so as to maintain all Work, materials, apparatus and fixtures free from damage. At the end of the day's work, all new Work likely to be damaged shall be reasonably protected against such weather.

§ 10.2.11 The Contractor shall provide adequate fire protection for all operations associated with the Work, and such protection must meet all applicable federal (including OSHA), State and municipal regulations.

§ 10.2.12 The Contractor shall remove and replace with new Work, at the Contractor's own expense, any Work damaged by failure to provide protection pursuant to Sections 10.2.10 and 10.2.11.

§ 10.2.13 **Fire Protection:** During any flame cutting and/or welding operation for the Work, the Contractor shall use or require Subcontractors or other persons performing such Work to use incombustible curtains and blankets to intercept, contain, and otherwise prevent the spread of hot metal, sparks and burning embers. In the performance of such Work, the Contractor shall employ a watchperson equipped with portable fire extinguishing equipment to maintain a fire watch

continuously during all flame cutting and welding operation and for four (4) hours minimum thereafter. No flammable rubbish or liquid shall be kept in any part of the existing buildings at the site, except one-gallon quantities in approved safety cans or sealed metal containers. All fire doors at the site shall be kept clear of rubbish and in operating condition, and closed during non-working hours. The Contractor shall not allow any locking and blocking of any door in the existing building at the site during nonworking hours except entrance doors. Used construction materials, solvent soaked rags, empty volatile containers, and any other material or container which may be combustible shall be removed from the site each day at the conclusion of construction activities for the Work.

§ 10.2.14 The Contractor shall be responsible, to the extent not covered by insurance, for damage, loss or liability due to theft or vandalism to the Work and stored materials whether the same occurs while Work is in progress or not, and during the day or at night, or on weekdays, weekends or holidays.

§ 10.2.15 The Contractor shall protect and prevent damage to all finished and unfinished phases of the Work during the course of the Project.

§ 10.2.16 Securing the Site

The Contractor is responsible for securing, and preventing access by unauthorized individuals to, the Project site from such date as the Contractor, Subcontractors, suppliers, consultants, or agents commence the Work until the date of Final Completion, unless the Owner and Contractor agree in writing to an earlier date.

§ 10.3 Hazardous Materials and Substances

§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding any material, substance, chemical, waste, product, derivative, compound, mixture, solid, liquid, mineral or gas, whether naturally occurring or manmade, that is hazardous, toxic, or words of similar import or regulatory effect, and any petroleum or petroleum-derived products, radon, radioactive materials or wastes, asbestos in any form, lead or lead-containing materials, urea formaldehyde foam insulation, and polychlorinated biphenyls (collectively, "Hazardous Materials"). If the Contractor believes its Work will disturb or otherwise implicate any actual or suspected Hazardous Material or encounters a Hazardous Material not addressed in the Contract Documents, the Contractor shall not disturb any such Hazardous Material, immediately report the condition to the Owner and the Architect in writing and take all necessary precautions to prevent release of and exposure to the Hazardous Materials and foreseeable bodily injury or death to persons resulting from such Hazardous Material. If such reasonable precautions will be inadequate to prevent release of and exposure to Hazardous Materials, or foreseeable bodily injury and death, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area.

§ 10.3.2 Upon receipt of the Contractor's notice pursuant to Section 10.3.1 of the existence of actual or suspect Hazardous Materials not addressed in the Contract Documents, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the Hazardous Material or substance reported by the Contractor and, in the event such Hazardous Material or substance is found to be present, to cause it to be rendered harmless or abated, or otherwise obtain verification from such licensed laboratory that such Hazardous Material or substances has been rendered harmless. When the Hazardous Material or substance has been rendered harmless and/or otherwise abated in accordance with all applicable Legal Requirements, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time may be extended appropriately, and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional costs of shutdown and start-up.

§ 10.3.3 Intentionally omitted.

§ 10.3.4 The Owner shall not be responsible under this Section 10.3 for Hazardous Materials or substances the Contractor, any Subcontractor, Sub-subcontractor, materialman or supplier, or any person or entity for whom or which any of them is responsible, brings to the site. The Contractor shall be responsible for the Contractor's fault or negligence and the fault or negligence of any of any Subcontractor, Sub-subcontractor, materialman or supplier, or any person or entity for whom or which any of them is responsible to the Owner, in the use and handling of such Hazardous Materials or substances required by the Contract Documents and/or a failure by any of them to comply with the Contract Documents or applicable Legal Requirements. The Contractor agrees not to use any fill or other materials to be incorporated into the Work which are hazardous, toxic or comprised of any items that are hazardous or toxic except to the extent required by the Contract Documents.

§ 10.3.5 To the fullest extent permitted by law, the Contractor shall indemnify, defend and hold harmless the Owner, its agents and employees, and the State of Connecticut, against claims, damages, losses and expenses, including but not limited to attorney's fees, resulting from (1) an actual or suspect Hazardous Material which the Contractor, any Subcontractor, Sub-subcontractor, supplier or any other person or entity for whom or which any of them is responsible to the Owner, brings to the Project site and negligently handles, or (2) the Contractor's failure to perform its obligations under Section 10.3.1, except to the extent that the claims, damages, losses, costs and expenses are due to the Owner's fault or negligence.

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

§ 10.3.7 The Contractor shall perform all required procedures necessary to ensure that there will be no release, discharge, spillage, uncontrolled loss, seepage or filtration (each a "Release") of any Hazardous Material brought on the Project site by the Contractor, any Subcontractor, Sub-subcontractor or supplier in the course of the performance of the Work. The Contractor is responsible for any and all costs and liabilities associated with the investigation and remediation of any such Release, or as required by regulating authorities having jurisdiction under any of the applicable Legal Requirements, and holds the Owner, its employees and agents, and the fee owner of the Project site (if other than the Owner), harmless against any current or future liabilities resulting from such incidents.

§ 10.3.8 All material and equipment furnished under the Contract Documents shall be free of asbestos, lead based paint, and PCBs. Unless otherwise specified in the Contract Documents, any material or equipment containing these, and any other Hazardous Materials shall be considered defective and shall be removed by the Contractor at the Contractor's sole expense.

§ 10.4 Emergencies

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury, or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7. The Contractor shall promptly notify insurers as applicable, and the Architect and the Owner of the nature of the emergency. Immediately thereafter, the Contractor shall submit to the Architect and the Owner a written report including description of circumstances of the emergency and details of actions taken.

§ 10.4.1 The Contractor shall furnish the Owner and Architect, in writing, the names, addresses and telephone numbers of the Contractor's personnel to be contacted in the event of an emergency, including without limitation emergencies that occur after normal working hours.

ARTICLE 11 INSURANCE AND BONDS

§ 11.1 Contractor's Insurance and Bonds

§ 11.1.1 The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Contractor shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized and properly licensed to issue insurance in the jurisdiction where the Project is located. The Owner and such other parties as are identified in the Contract Documents and such others as may be required by the Owner, shall be named as additional insureds under the Contractor's liability insurance policies required under the Contract Documents to be procured and maintained by the Contractor.

§ 11.1.2 The Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized and properly licensed to issue surety bonds in the jurisdiction where the Project is located.

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

§ 11.1.4 Notice of Cancellation or Expiration of Contractor's Required Insurance. Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act or omission of the Owner, have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. In the event of such suspension, the Contractor shall be responsible for, and shall not receive an extension of the Contract Time in connection with, the delay in the Work arising from the suspension. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.

§ 11.2 Owner's Insurance

§ 11.2.1 The Owner shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as customarily maintained by the Owner.

§ 11.2.2 Property Insurance. If the Contractor is required under the Contract Documents to maintain property insurance for the Project and fails to purchase and maintain such insurance, with all of the coverages and in the amounts described in the Agreement or elsewhere in the Contract Documents, the Contractor shall be responsible to the Owner for all of the Owner's losses, costs and damages caused by, arising from or attributable thereto to the extent that such losses, costs and damages would have been covered by such insurance.

§ 11.2.3 Notice of Cancellation or Expiration of Contractor's Required Property Insurance. Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of property insurance required to be maintained by the Contractor under the Contract Documents, if any, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Unless the lapse in coverage arises from an act or omission of the Owner, upon receipt of notice from the Contractor, the Owner shall have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by either the Owner or the Contractor. If the Owner purchases replacement coverage, the cost of the insurance shall be charged to the Contractor by an appropriate Change Order. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide required insurance or responsibility to the Owner pursuant to Section 11.2.2.

§ 11.3 Waivers of Subrogation

§ 11.3.1 If the Contractor is required under the Contract Documents to maintain property insurance for the Project, the Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents, and employees, each of the other; (2) the Architect and Architect's consultants; and (3) Separate Contractors, if any, and any of their subcontractors, sub-subcontractors, agents, and employees, for damages caused by fire, or other causes of loss, to the extent those losses are covered by the Contractor's property insurance, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require similar written waivers in favor of the individuals and entities identified above from the Architect, Architect's consultants, Separate Contractors, subcontractors, and sub-subcontractors. Such policy of insurance shall not prohibit this waiver of subrogation. This waiver of subrogation shall be effective as to a person or entity (1) even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, (2) even though that person or entity did not pay the insurance premium directly or indirectly, or (3) whether or not the person or entity had an insurable interest in the damaged property.

§ 11.3.2 Intentionally omitted.

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

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

§ 11.5 Adjustment and Settlement of Insured Loss

§ 11.5.1 A loss insured under any property insurance required by the Agreement shall be adjusted by the Owner and made payable to the Owner for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.5.2. The Owner shall pay the Architect and Contractor their just shares of insurance proceeds

received by the Owner, and by appropriate agreements the Architect and Contractor shall make payments to their consultants and Subcontractors in similar manner.

§ 11.5.2 Prior to settlement of an insured loss, the Owner shall notify the Contractor of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The Contractor shall have 5 days from receipt of notice to object to the proposed settlement or allocation of the proceeds. If the Contractor does not object, the Owner may settle the loss and the Contractor shall be bound by the settlement and allocation. Upon receipt, the Owner shall make the appropriate distributions. Thereafter, if no other agreement is made or the Owner does not terminate the Contract for convenience, the Owner and Contractor shall execute a Change Order for reconstruction of the damaged or destroyed Work in the amount allocated for that purpose. If the Contractor timely objects to either the terms of the proposed settlement or the allocation of the proceeds, the Owner may proceed to settle the insured loss, and any dispute between the Owner and Contractor arising out of the settlement or allocation of the proceeds shall be resolved pursuant to Article 15. Pending resolution of any dispute, the Owner may issue a Construction Change Directive for the reconstruction of the damaged or destroyed Work.

§ 11.6 Performance Bond and Payment Bond

§ 11.6.1 The Owner shall have the right to require the Contractor to furnish bonds covering faithful performance of the Contract and payment of obligations arising thereunder as stipulated in bidding requirements or specifically required in the Contract Documents on the date of execution of the Contract.

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

§ 11.6.3 The Contractor shall increase the principal amount of the performance and labor and materials payments bond(s) in direct proportion to any increase in the Contract Sum resulting from Change Orders.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 Uncovering of Work

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

§ 12.1.2 If a portion of the Work has been covered that the Architect or Owner has not specifically requested to examine prior to its being covered, the Architect or Owner may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, the Contractor shall be entitled to an equitable adjustment to the Contract Sum and Contract Time as may be appropriate. If such Work is not in accordance with the Contract Documents, the costs of uncovering the Work, and the cost of correction, shall be at the Contractor's expense.

§ 12.2 Correction of Work

§ 12.2.1 Before Substantial Completion

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

§ 12.2.2 After Substantial Completion

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within two years after the date of Substantial Completion of the Work or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly at the Contractor's sole expense after receipt of notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or

Architect, the Owner may correct it in accordance with Section 2.5.

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

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

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

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

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to modify the Contractor's obligations under Section 3.5 or to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the two-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ 12.2.6 Audits

Upon request of the Owner, the Contractor will cooperate, and secure the cooperation of all Subcontractors, suppliers, and Sub-subcontractors, and assist the Owner during any audit of the Project conducted by the Owner and/or DAS at any time after Substantial Completion at no cost to the Owner. Such cooperation shall include providing the Owner with access to all records related to the Project.

§ 12.3 Acceptance of Nonconforming Work

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 Governing Law

The Contract shall be governed by the law of the place where the Project is located, excluding that jurisdiction's choice of law rules.

§ 13.2 Successors and Assigns

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

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

§ 13.3 Rights and Remedies

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

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

§ 13.3.3 No provision contained in the Contract Documents shall create or give to third parties any claim or right against the Owner or the Contractor except as specifically provided herein.

§ 13.4 Tests and Inspections

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

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

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

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

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

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

§ 13.5 Interest

Payments due and unpaid under the Contract Documents shall bear interest as provided in the Agreement.

§ 13.6 Prohibited Activities and Background Check Requirements

§ 13.6.1 Contractor shall comply with all applicable Legal Requirements including, without limitation, Connecticut General Statutes Section 10-222c, as applicable.

§ 13.6.2 **Interaction with School Community.** The scope of the Work does not, and will not under any circumstances, require any contact with students or any other minors physically present in the facilities of, or the grounds surrounding, the school where the Project is located (the "School Grounds"). None of the Contractor, Subcontractors, Sub-subcontractor, or any of their respective employees, agents or representatives shall, under any circumstances, converse or interact in any manner, with students or any minors physically present on the School Grounds. None of the Contractor, Subcontractors, Sub-subcontractor, or any of their respective employees, agents or representatives shall interact with any adult members of the school community (including, without limitation, employees, officials, or visitors, including parents of students enrolled in

the Owner's schools) with respect to the Project with the exception of the Owner's Designated Representative as provided in the Agreement. All of the Contractor, Subcontractors, Sub-subcontractors, and their respective employees, agents or representatives shall, while on the School Grounds, refrain from use of vulgar language, obscene gestures, or any other behavior inappropriate for a school environment and/or property on which minor children are or may be present.

§ 13.6.3 Background and Employment History Checks

§ 13.6.3.1 To the extent permitted by law, the Contractor shall perform (or cause to be performed) as regards all of its employees, agents, and representatives (each a "Contractor Employee"), and all of the employees, agents, and representatives of Subcontractors and Sub-subcontractors (each a "Subcontractor Employee"), who will be physically present on the School Grounds in connection with the Project, appropriate background checks on all such Contractor Employees and Subcontractor Employees. Such background checks shall include, at a minimum and without limitation, a search of both the Connecticut Department of Emergency Services and Public Protection's sexual offender registry and the Abuse and Neglect Registry of the Connecticut Department of Children and Families. For those Contractor Employees and Subcontractor Employees who are to be physically present on the School Grounds in connection with the Project and whose current or most recent employment occurred out of state, the out-of-state equivalent of the Connecticut Department of Emergency Services and Public Protection's sexual offender registry and the Abuse and Neglect Registry of the Connecticut Department of Children and Families registry shall be checked. The Contractor shall complete (or cause to be completed) background checks as to each Contractor Employee and Subcontractor Employee prior to such Contractor Employee or Subcontractor Employee being permitted to be physically present on the School Grounds. If the Contractor receives any information indicating that any Contractor Employee or Subcontractor Employee may be registered as a sexual offender, may have a record of abuse or neglect, or is, in any other manner, unfit to perform services which could involve direct contact with minor children, or which may involve working in or near property on which minor children may be present, the Contractor shall immediately forward such information to the Owner, to the extent permitted by law, and shall immediately remove the individual from the School Grounds and from participation in the Project.

§ 13.6.3.2 The Contractor represents and warrants that, in its best professional judgment, each Contractor Employee and each Subcontractor Employee maintains the appropriate qualifications and is fit to perform services which could involve direct contact with minor children, or which may involve working in or near property on which minor children may be present. The Contractor shall immediately remove any Contractor Employee or Subcontractor Employee from the School Grounds and from the Project if requested to do so by the Owner (which request shall be made in the Owner's sole discretion) or if it becomes known to the Contractor that such Contractor Employee or Subcontractor Employee may be a danger to the health, safety or well-being of the school community, its students, or any minor children.

§ 13.6.3.3 The Contractor shall include and shall require all Subcontractors to include this Section 13.6 in all Subcontracts for the Project.

§ 13.6.3.4 By execution of the Contract, the Contractor represents and warrants that it has fully complied with the requirements of this Section 13.6. To the extent permitted by law, the Contractor agrees that upon the Owner's request, Contractor shall promptly provide the Owner with any documentation related to such compliance, including, without limitation, the results of the background and employment history checks required by this Section.

§ 13.6.3.5 Failure by the Contractor to comply with its obligations under this Section 13.6 shall constitute a material breach of the Contract.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 Termination by the Contractor

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

- .1 Issuance of an order of a court or other governmental authority having jurisdiction that requires all Work to be stopped;
- .2 An act of government, such as a declaration of national emergency, that requires all Work to be stopped; or
- .3 Because the Owner has repeatedly defaulted, beyond any applicable notice and cure periods, in its payment obligations to the Contractor under the Contract Documents.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor, a Subcontractor, a Sub-

subcontractor, supplier or any of their respective agents or employees, or any other persons or entities performing portions of the Work, repeated suspensions, delays, or interruptions of the entire Work by the Owner as described in Section 14.3, constitute in the aggregate more than one hundred percent (100%) of the total number of days scheduled for completion of the Work, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon ten days' prior written notice to the Owner and the Architect, terminate the Contract and recover from the Owner payment pursuant to the Contract Documents for Work executed in accordance with the Contract Documents, along with direct costs incurred by the Contractor by reason of such termination.

§ 14.1.4 If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, supplier or their respective agents or employees or any other persons or entities performing portions of the Work by or on behalf of any of them, because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important and critical to the progress of the Work, the Contractor may, upon 10 additional days' prior written notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ 14.1.5 The notice of termination delivered pursuant to Section 14.1.3 or 14.1.4 must state with specificity the means by which the Owner may cure its nonperformance, and the Contractor shall not terminate the Contract if, within the applicable ten (10) day period, the Owner substantially takes such curative measures.

§ 14.2 Termination by the Owner for Cause

§ 14.2.1 The Owner may, without prejudice to and without waiving any other rights or remedies the Owner may have, terminate the Contract if the Contractor

- .1 repeatedly refuses or fails to supply enough properly skilled workers or proper materials;
- .2 fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or suppliers;
- .3 disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority;
- .4 otherwise is guilty of substantial breach of a provision of the Contract Documents;
- .5 institutes proceedings or consent to proceedings requesting relief or arrangement under the Federal Bankruptcy Act or similar or applicable federal or state law, or a petition under any federal or state bankruptcy or insolvency law is filed against the Contractor and such petition is not dismissed within sixty (60) days from the date of said filing, or the Contractor admits in writing its inability to pay its debts as they become due, or it makes a general assignment for the benefit of its creditors, or a receiver, liquidator, trustee, or assignee is appointed, or a receiver of all or any substantial portion of the Contractor's properties is appointed;
- .6 abandons the Work;
- .7 fails to prosecute the Work promptly and diligently;
- .8 submits an Application for Payment, sworn statement, waiver of lien, affidavit or document of any nature whatsoever which is intentionally falsified;
- .9 fails to make prompt payment to Subcontractors or for materials or labor in accordance with the respective Subcontracts or otherwise breaches its obligations under any Subcontract with a Subcontractor; or
- .10 after a mechanics or materialman's lien or notice of lien is filed against any part of the Work or the Project site, the lien and underlying claim are not promptly resolved as required under the Contract Documents.

§ 14.2.2 When any of the reasons described in Section 14.2.1 exist, the Owner may, without prejudice to and without waiving any other rights or remedies the Owner may have, and after giving the Contractor and the Contractor's surety, if any, seven days' notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

- .1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- .2 Accept assignment of subcontracts pursuant to Section 5.4; and
- .3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

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

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.3 Suspension by the Owner for Convenience

§ 14.3.1 The Owner may, without cause, and without prejudice and without waiving any other rights or remedies the Owner may have, order the Contractor in writing to suspend, delay or interrupt the Work, in whole or in part for such period of time as the Owner may determine.

§ 14.3.2 The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay, or interruption under Section 14.3.1. Adjustment of the Contract Sum shall include profit to the extent provided and permitted in the Contract Documents. No adjustment shall be made to the extent

- .1 that performance is, was, or would have been, so suspended, delayed, or interrupted, by another cause for which the Contractor is responsible; or
- .2 that an equitable adjustment is made or denied under another provision of the Contract.

§ 14.4 Termination by the Owner for Convenience

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of notice from the Owner of such termination for the Owner's convenience, the Contractor shall

- .1 cease operations as directed by the Owner in the notice;
- .2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and
- .3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing Subcontracts and purchase orders and enter into no further Subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Owner shall pay the Contractor for Work properly executed in accordance with the Contract Documents and direct costs incurred by reason of the termination, including costs directly attributable to termination of Subcontracts.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 Claims

§ 15.1.1 Definition

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, a change in the Contract Time, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim. This Section 15.1.1 does not require the Owner to file a Claim in order to impose liquidated damages in accordance with the Contract Documents.

§ 15.1.2 Time Limits on Claims

The Owner and Contractor shall commence all Claims and causes of action against the other and arising out of or related to the Contract, whether in contract, tort, breach of warranty or otherwise, in accordance with the requirements of the binding dispute resolution method selected in the Agreement and within the period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all Claims and causes of action not commenced in accordance with this Section 15.1.2.

§ 15.1.3 Notice of Claims

§ 15.1.3.1 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered prior to expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other

party and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by either party under this Section 15.1.3.1 shall be initiated within 10 days after occurrence of the event giving rise to such Claim or within 10 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

§ 15.1.3.2 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party. In such event, no decision by the Initial Decision Maker is required.

§ 15.1.4 Continuing Contract Performance

§ 15.1.4.1 Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Work and its obligations under the Contract Documents and the Owner shall continue to make payments in accordance with the Contract Documents.

§ 15.1.4.2 The Contract Sum and Contract Time shall be adjusted in accordance with the Initial Decision Maker's decision, subject to the right of either party to proceed in accordance with this Article 15. The Architect will issue Certificates for Payment in accordance with the decisions of the Initial Decision Maker.

§ 15.1.5 Claims for Additional Cost

If the Contractor wishes to make a Claim for an increase in the Contract Sum, notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ 15.1.6 Claims for Additional Time

§ 15.1.6.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, notice as provided in Section 15.1.3 shall be given. The Contractor's Claim shall include an estimate of the probable effect of the delay on the progress of the Work. In the case of a continuing delay, only one Claim is necessary.

§ 15.1.6.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction. No extension of the Contract Time will be granted for adverse weather conditions unless the number of days of inclement weather is substantially greater or conditions substantially more severe than the average for the calendar period as recorded by a recognized weather observation government agency.

§ 15.1.7 Intentionally omitted.

§ 15.1.8 Notwithstanding anything to the contrary herein or in the Contract Documents, neither the Contract Sum nor the Contract Time shall be adjusted if the increased costs or delay underlying the Contractor's claim for adjustment stems from the negligent act or omission of the Contractor, its subcontractors of any tier, or of anyone for whose performance the Contractor is responsible to the Owner, or as a result of the error of any of the same or of the failure of any of the same to comply with, and fulfill their responsibilities under, the Contract Documents.

§ 15.2 Initial Decision

§ 15.2.1 Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Sections 10.3, 10.4, and 11.5, shall be referred to the Initial Decision Maker for initial decision. The Architect will serve as the Initial Decision Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to mediation of any Claim. If an initial decision has not been rendered within 45 days after the Claim has been referred to the Initial Decision Maker, the party asserting the Claim may demand mediation and binding dispute resolution without a decision having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Initial Decision Maker will review Claims and within ten days after the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the

other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the Initial Decision Maker's sole discretion, it would be inappropriate for the Initial Decision Maker to resolve the Claim.

§ 15.2.3 In evaluating Claims, the Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering a decision. The Initial Decision Maker may request the claimant to authorize retention of such persons at the claimant's expense.

§ 15.2.4 If the Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of the request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished, or (3) advise the Initial Decision Maker that no supporting data will be furnished. Within ten days after receipt of the response or supporting data, if any, the Initial Decision Maker will either reject or approve the Claim in whole or in part, or suggest a compromise.

§ 15.2.5 The Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to binding dispute resolution.

§ 15.2.6 Either party may file for mediation of an initial decision at any time, subject to the terms of Section 15.2.6.1.

§ 15.2.6.1 Either party may, within 30 days from the date of receipt of an initial decision, demand in writing that the other party file for mediation. If such a demand is made and the party receiving the demand fails to file for mediation within 30 days after receipt thereof, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.

§ 15.2.7 In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ 15.2.8 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

§ 15.3 Mediation

§ 15.3.1 Claims, disputes, or other matters in controversy arising out of or related to the Contract, except those waived as provided for in Section 9.10.5, shall be subject to mediation as a condition precedent to binding dispute resolution.

§ 15.3.2 The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. The request may be made concurrently with the filing of binding dispute resolution proceedings but, in such event, mediation shall proceed in advance of binding dispute resolution proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. If an arbitration is stayed pursuant to this Section 15.3.2, the parties may nonetheless proceed to the selection of the arbitrator(s) and agree upon a schedule for later proceedings.

§ 15.3.3 Either party may, within 30 days from the date that mediation has been concluded without resolution of the dispute or 60 days after mediation has been demanded without resolution of the dispute, demand in writing that the other party file for binding dispute resolution. If such a demand is made and the party receiving the demand fails to file for binding dispute resolution within 60 days after receipt thereof, then both parties waive their rights to binding dispute resolution proceedings with respect to the initial decision.

§ 15.3.4 The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

§ 15.4 Intentionally Omitted

§ 15.4.1 Intentionally omitted.

§ 15.4.1.1 Intentionally omitted.

§ 15.4.2 Intentionally omitted.

§ 15.4.3 Intentionally omitted.

§ 15.4.4 Intentionally omitted.

§ 15.4.4.1 Intentionally omitted.

§ 15.4.4.2 Intentionally omitted.

§ 15.4.4.3 Intentionally omitted.

 AIA Document G702® – 1992

Application and Certificate for Payment

TO OWNER:

PROJECT: GENERIC

APPLICATION NO: 001

Distribution to:
OWNER: []
ARCHITECT: []
CONTRACTOR: []
FIELD: []
OTHER: []

FROM

VIA

CONTRACTOR:

ARCHITECT:

PERIOD TO: January 1, 2026

CONTRACT FOR:

CONTRACT DATE: 01-06-2026

PROJECT NOS: / /

CONTRACTOR'S APPLICATION FOR PAYMENT
Application is made for payment, as shown below, in connection with the Contract.
AIA Document G703*, Continuation Sheet, is attached.

The undersigned Contractor certifies that to the best of the Contractor's knowledge, information and belief the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by the Contractor for Work for which previous Certificates for Payment were issued and payments received from the Owner, and that current payment shown herein is now due.

1. ORIGINAL CONTRACT SUM 0.00

2. NET CHANGE BY CHANGE ORDERS 0.00 CONTRACTOR:

3. CONTRACT SUM TO DATE (Line 1 ± 2) 0.00 By: Date:

4. TOTAL COMPLETED & STORED TO DATE (Column G on G703) 0.00 State of: County of:

5. RETAINAGE:
a. 0.00% of Completed Work (Column D + E on G703) 0.00 Subscribed and sworn to before me this day of
b. 0.00% of Stored Material (Column F on G703) 0.00 Notary Public:
My Commission expires: 0.00

Total Retainage (Lines 5a + 5b or Total in Column I of G703) 0.00

6. TOTAL EARNED LESS RETAINAGE (Line 4 Less Line 5 Total) 0.00

7. LESS PREVIOUS CERTIFICATES FOR PAYMENT (Line 6 from prior Certificate) 0.00

8. CURRENT PAYMENT DUE 0.00 AMOUNT CERTIFIED 0.00

9. BALANCE TO FINISH, INCLUDING RETAINAGE (Line 3 less Line 6) 0.00

(Attach explanation if amount certified differs from the amount applied. Initial all figures on this Application and on the Continuation Sheet that are changed to conform with the amount certified.)

ARCHITECT'S CERTIFICATE FOR PAYMENT
In accordance with the Contract Documents, based on on-site observations and the data comprising this application, the Architect certifies to the Owner that to the best of the Architect's knowledge, information and belief the Work has progressed as indicated, the quality of the Work is in accordance with the Contract Documents, and the Contractor is entitled to payment of the AMOUNT CERTIFIED.

CHANGE ORDER SUMMARY	ADDITIONS	DEDUCTIONS
Total changes approved in previous months by Owner	0.00	0.00
Total approved this Month	0.00	0.00
TOTALS	0.00	0.00
NET CHANGES by Change Order		0.00

This Certificate is not negotiable. The AMOUNT CERTIFIED is payable only to the Contractor named herein. Issuance, payment and acceptance of payment are without prejudice to any rights of the Owner or Contractor under this Contract.

ATA® Document G703® - 1992

Continuation Sheet

AIA Document G702⁶, Application and Certification for Payment, or G732TM,

containing Contractor's signed certification is attached.

Use Column I on Contracts where variable retainage for line items may apply.

[illegible]

CONNECTICUT DEPARTMENT OF LABOR
WAGE AND WORKPLACE STANDARDS DIVISION

CONTRACTORS WAGE CERTIFICATION FORM
Construction Manager at Risk/General Contractor/Prime Contractor

I, _____ of _____
Officer, Owner, Authorized Rep. Company Name

do hereby certify that the _____
Company Name

Street

City

and all of its subcontractors will pay all workers on the

Project Name and Number

Street and City

the wages as listed in the schedule of prevailing rates required for such project (a copy of which is attached hereto).

Signed

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

Notary Public

Return to:

Connecticut Department of Labor
Wage & Workplace Standards Division
200 Folly Brook Blvd.
Wethersfield, CT 06109

Rate Schedule Issued (Date): _____

Minimum Rates and Classifications
for Building Construction

ID#: 26-4805

Connecticut Department of Labor
Wage and Workplace Standards Division

By virtue of the authority vested in the Labor Commissioner under provisions of Section 31-53 of the General Statutes of Connecticut, as amended, the following are declared to be the prevailing rates and welfare payments and will apply only where the contract is advertised for bid within 20 days of the date on which the rates are established. Any contractor or subcontractor not obligated by agreement to pay to the welfare and pension fund shall pay this amount to each employee as part of his/her hourly wages.

Project Number: Project Town: Woodbridge
State#: FAP#:
Project: Amity Regional High School: Media Center Interior Alterations

CLASSIFICATION	Hourly Rate	Benefits
1b) Asbestos/Toxic Waste Removal Laborers: Asbestos removal and encapsulation (except its removal from mechanical systems which are not to be scrapped), toxic waste removers, blasters.**See Laborers Group 7**		
1c) Asbestos Worker/Heat and Frost Insulator	48.81	34.05
2) Boilermaker	50.21	30.01
3a) Bricklayer, Cement Mason, Concrete Finisher (including caulking), Stone Masons	45.76	38.45 + a
3b) Tile Setter	43.0	34.75
3c) Tile and Stone Finishers	36.0	29.43
3d) Marble & Terrazzo Finishers	35.7	29.73
3e) Plasterer	44.52	29.63

3f) Terrazzo Mechanics & Marble Setters	40.6	39.93
-----LABORERS-----		
4) Group 1: General laborers, carpenter tenders, concrete specialists, wrecking laborers and fire watchers.	37.0	30.47
4) Group 1a: Acetylene Burners (Hours worked with a torch)	38.0	30.47
4a) Group 2: Mortar mixers, plaster tender, power buggy operators, powdermen, fireproofers/mixer/nozzleman (Person running mixer and spraying fireproof only).	37.25	30.47
4b) Group 3: Jackhammer operators/pavement breaker, mason tender (brick), mason tender (cement/concrete), forklift operators and forklift operators (masonry).	37.5	30.47
4c) **Group 4: Pipelayers: Licensed P6 -P7 (one or two employees of the total crew who primary task is to perform mating of pipe sections).	38.0	30.47
4d) Group 5: Air track operator, sand blaster and hydraulic drills.	37.75	30.47
4e) Group 6: Blasters, nuclear and toxic waste removal.	40.0	30.47
4f) Group 7: Asbestos/lead removal and encapsulation (except it's removal from mechanical systems which are not to be scrapped).	40.0	30.47
4g) Group 8: Bottom men on open air caisson, cylindrical work and boring crew.	37.5	30.47
4h) Group 9: Top men on open air caisson, cylindrical work and boring crew.	37.0	30.47

As of: April 30, 2026

4i) Group 10: Traffic Control Signalman	22.2	30.47
4j) Group 11: Toxic Waste Removers A or B With PPE	40.0	30.47
5) Carpenter, Acoustical Ceiling Installation, Soft Floor/Carpet Laying, Metal Stud Installation, Form Work and Scaffold Building, Drywall Hanging, Modular-Furniture Systems Installers, Lathers, Piledrivers, Resilient Floor Layers.	42.03	29.19
5a) Millwrights	43.25	29.13
5b) Carpenter - Welder	42.53	29.19
5c) Carpenter: Working with creosote lumber or acid	43.03	29.19
6) Electrical Worker (including low voltage wiring) (Trade License required: E1,2 L-5,6 C-5,6 T-1,2 L-1,2 V-1,2,7,8,9)	46.4	36.66+3% of gross wage
7a) Elevator Mechanic (Trade License required: R-1,2,5,6)	69.55	38.985+a+b
-----OUTSIDE LINE CONSTRUCTION-----		
Groundman	32.1	13.95
Linemen/Cable Splicer	58.37	33.94
8) Glazier (Trade License required: FG-1,2)	43.13	26.50+ a

9) Ironworker, Ornamental, Reinforcing, Structural, and Precast Concrete Erection	45.25	43.62 + a

----OPERATORS----

Group 1: Crane Handling or Erecting Structural Steel or Stone, Hoisting Engineer (2 drums or over), Deep Shaft over 14". (Trade License Required)	60.66	30.95 + a

Group 1a: Front End Loader (7 cubic yards or over); Work Boat 26 ft. and Over	55.6	30.95 + a

Group 2: Cranes (100 ton rate capacity and over). (Trade License Required)	60.24	30.95 + a

Group 2a: Cranes (under 100 ton rated capacity), Magni Type-360 Rotating Forklift.	59.2	30.95 + a

Group 2b: Excavator over 2 cubic yards; Pile Driver (\$3.00 premium when operator controls hammer), HF-1 Forklift, Drills with self contained power units, Micropile up to 14 inches helical pile.	55.17	30.95 + a

Group 3: Excavator; Gradall; Master Mechanic; Hoisting Engineer (all types of equipment where a drum and cable are used to hoist or drag material regardless of motive power of operation), Rubber Tire Excavator (Drott-1085 or similar); Grader Operator; Bulldozer Finegrade. (slopes, shaping, laser or GPS, etc.). (Trade License Required)	54.13	30.95 + a

Group 4: Trenching Machines; Lighter Derrick; CMI Machine or Similar; Koehring Loader (Skooper); Goldhofer.	53.61	30.95 + a

Group 5: Specialty Railroad Equipment; Asphalt Spreader, Asphalt Reclaiming Machine; Line Grinder; Concrete Pumps; Drills with Self Contained Power Units; Boring Machine; Post Hole Digger; Auger; Pounder; Well Digger; Milling Machine (over 24 mandrel).	52.78	30.95 + a

Group 5 continued: Side Boom; Combination Hoe and Loader; Directional Driller, Geothermal Drill.	52.78	30.95 + a

As of: April 30, 2026

Group 6: Front End Loader (3 up to 7 cubic yards); Bulldozer (rough grade dozer).	52.35	30.95 + a
Group 7: Asphalt Roller; Concrete Saws and Cutters (ride on types); Vermeer Concrete Cutter; Stump Grinder; Scraper; Snooper; Skidder; Milling Machine (24" and under mandrel).	51.89	30.95 + a
Group 8: Mechanic; Grease Truck Operator; Hydroblaster; Barrier Mover; Power Stone Spreader; Welding; Work Boat Under 26 ft.; Transfer Machine; Rigger Foreman.	51.34	30.95 + a
Group 9: Front End Loader (under 3 cubic yards); Skid Steer Loader regardless of attachments; (Bobcat or Similar); Forklift, Power Chipper; Landscape Equipment (including Hydroseeder); Vacuum Excavation Truck and Hydrovac Excavation Truck (27 HG pressure or greater).	50.74	30.95 + a
Group 10: Vibratory hammer; ice machine; diesel and air, hammer, etc.	47.91	30.95 + a
Group 11: Conveyor, earth roller, power pavement breaker (whiphammer), robot demolition equipment.	47.91	30.95 + a
Group 12: Wellpoint Operator.	47.82	30.95 + a
Group 13: Compressor Battery Operator.	47.04	30.95 + a
Group 14: Elevator Operator; Tow Motor Operator (solid tire no rough terrain).	45.45	30.95 + a
Group 15: Generator Operator; Compressor Operator; Pump Operator; Welding Machine Operator; Heater Operator.	44.89	30.95 + a
Group 16: Maintenance Engineer and Articulating End Dump.	43.99	30.95 + a

As of: April 30, 2026

Group 17: Portable Asphalt Plant Operator; Portable Crusher Plant Operator; Portable Concrete Plant Operator; Portable Grout Plant Operator; Portable Water Filtration Plant Operator.	49.95	30.95 + a

Group 18: Power Safety Boat; Vacuum Truck; Zim Mixer; Sweeper; (Minimum for any job requiring a CDL license); Rigger; Signalman.	46.6	30.95 + a

Surveyor: Chief of Party	50.21	30.95 + a

Surveyor: Assistant Chief of Party	46.3	30.95 + a

Surveyor: Instrument Man	44.55	30.95 + a

Surveyor: Rodman or Chainman	38.34	30.95 + a

-----PAINTERS (Including Drywall Finishing)-----

10a) Brush and Roller	39.57	26.50

10b) Taping Only/Drywall Finishing	40.32	26.50

10c) Paperhanger and Red Label	40.07	26.50

10d) Spray	42.57	26.50

10e) Spray Helper	40.57	26.50

10f) Blast	44.57	26.50

10g) Blast Helper	40.57	26.50
11) Plumber (excluding HVAC pipe installation) (Trade License required: P-1,2,6,7,8,9 J-1,2,3,4 SP-1,2)	50.58	36.30
12) Well Digger, Pile Testing Machine	37.26	24.05 + a
Roofer: Cole Tar Pitch	46.0	24.74 + a
Roofer: Slate, Tile, Composition, Shingles, Singly Ply and Damp/Waterproofing	44.5	24.74 + a
15) Sheetmetal Worker (Trade License required for HVAC and Ductwork: SM-1,SM-2,SM-3,SM-4,SM-5,SM-6)	44.7	44.38
16) Pipefitter (Including HVAC work) (Trade License required: S-1,2,3,4,5,6,7,8 B-1,2,3,4 D-1,2,3,4, G-1, G-2, G-8 & G-9)	50.58	36.30
-----TRUCK DRIVERS-----		
17) Block Truck	39.98	33.00 + a
17a) 2 Axle	38.66	33.00 + a
17ab) Helpers	36.16	33.00 + a
17b) 3 Axle, 2 Axle Mixer	38.77	33.00 + a

17c) 3 Axle Mixer	38.83	33.00 + a
17d) 4 Axle	38.89	33.00 + a
17e) 4 Axle Mixer	40.69	33.00 + a
17ef) 5 Axle	38.89	33.00 + a
17eg) 5 Axle Mixer	40.69	33.00 + a
17f) Heavy Duty Trailer (40 Tons and Over)	41.16	33.00 + a
17g) Euclids and Semi-Trailer	38.94	33.00 + a
17h) Heavy Duty Trailer up to 40 tons	39.89	33.00 + a
17i) Snorkle Truck	39.04	33.00 + a
17j) Swivel Dump and Tack Truck	38.89	33.00 + a
18) Sprinkler Fitter (Trade License required: F-1,2,3,4)	56.78	35.24 + a
19) Theatrical Stage Journeyman	25.76	7.34

Welders: Rate for craft to which welding is incidental.

Surveyors: Hazardous material removal: \$3.00 per hour premium.

*Note: Hazardous waste removal work receives additional \$1.25 per hour for truck drivers.

**Note: Hazardous waste premium \$3.00 per hour over classified rate.

Truck Drivers: Trainers Premium: \$3.00 over wage rate.

Truck Drivers: Night Premium - Mixer Drivers: \$2.00 over wage rate.

As of: April 30, 2026

Crane with 150 ft. boom (including jib) - \$1.50 extra
Crane with 200 ft. boom (including jib) - \$2.50 extra
Crane with 250 ft. boom (including jib) - \$5.00 extra
Crane with 300 ft. boom (including jib) - \$7.00 extra
Crane with 400 ft. boom (including jib) - \$10.00 extra

All classifications that indicate a percentage of the fringe benefits must be calculated at the percentage rate times the "base hourly rate".

Apprentices duly registered under the Commissioner of Labor's regulations on "Work Training Standards for Apprenticeship and Training Programs" Section 31-51-d-1 to 12, are allowed to be paid the appropriate percentage of the prevailing journeymen hourly base and the full fringe benefit rate, providing the work site ratio shall not be less than one full-time journeyman instructing and supervising the work of each apprentice in a specific trade.

The Prevailing wage rates applicable to this project are subject to annual adjustments each July 1st for the duration of the project.

Each contractor shall pay the annual adjusted prevailing wage rate that is in effect each July 1st, as posted by the Department of Labor.

It is the contractor's responsibility to obtain the annual adjusted prevailing wage rate increases directly from the Department of Labor's website.

The annual adjustments will be posted on the Department of Labor's Web page:

www.ct.gov/dol. For those without internet access, please contact the division listed below.

The Department of Labor will continue to issue the initial prevailing wage rate schedule to the Contracting Agency for the project.

All subsequent annual adjustments will be posted on our Web Site for contractor access.

Contracting Agencies are under no obligation pursuant to State labor law to pay any increase due to the annual adjustment provision.

Effective October 1, 2005 - Public Act 05-50: any person performing the work of any mechanic, laborer, or worker shall be paid prevailing wage

All Person who perform work ON SITE must be paid prevailing wage for the appropriate mechanic, laborer, or worker classification.

All certified payrolls must list the hours worked and wages paid to All Persons who perform work ON SITE regardless of their ownership i.e.: (Owners, Corporate Officers, LLC Members, Independent Contractors, et. al)

Reporting and payment of wages is required regardless of any contractual relationship alleged to exist between the contractor and such person.

~~Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clause (29 CFR 5.5 (a) (1) (ii)).

Please direct any questions which you may have pertaining to classification of work and payment of prevailing wages to the Wage and Workplace Standards Division, telephone (860)263-6790.

**Connecticut Department of Labor
Wage and Workplace Standards Division
FOOTNOTES**

- ⇒ Please Note: If the “Benefits” listed on the schedule for the following occupations includes a letter(s) (+ a or + a+b for instance), refer to the information below.

Benefits to be paid at the appropriate prevailing wage rate for the listed occupation.

If the “Benefits” section for the occupation lists only a dollar amount, disregard the information below.

Bricklayers, Cement Masons, Cement Finishers, Concrete Finishers, Stone Masons
(Building Construction) and
(Residential- Hartford, Middlesex, New Haven, New London and Tolland Counties)

- a. Paid Holiday: Employees shall receive 4 hours for Christmas Eve holiday provided the employee works the regularly scheduled day before and after the holiday. Employers may schedule work on Christmas Eve and employees shall receive pay for actual hours worked in addition to holiday pay.

Dredging (Heavy)

- a. Paid Holidays: New Year’s Day, Martin Luther King, Jr.’s Birthday, Memorial Day, Good Friday, Independence Day, Labor Day, Veterans’ Day, Thanksgiving Day and Christmas Day.
- b. Vacation: Eight Percent (8%) of the straight time rate, multiplied by the total hours worked.

Elevator Constructors: Mechanics

- a. Paid Holidays: New Year’s Day, Memorial Day, Independence Day, Labor Day, Veterans’ Day, Thanksgiving Day, Christmas Day, plus the Friday after Thanksgiving.
- b. Vacation: Employer contributes 8% of basic hourly rate for 5 years or more of service or 6% of basic hourly rate for 6 months to 5 years of service as vacation pay credit.

Glaziers

- a. Paid Holidays: Labor Day and Christmas Day.

Power Equipment Operators

(Heavy and Highway Construction & Building Construction)

- a. Paid Holidays: New Year's Day, Good Friday, Memorial day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day, provided the employee works 3 days during the week in which the holiday falls, if scheduled, and if scheduled, the working day before and the working day after the holiday. Holidays falling on Saturday may be observed on Saturday, or if the employer so elects, on the preceding Friday.

Ironworkers

- a. Paid Holiday: Labor Day provided employee has been on the payroll for the 5 consecutive work days prior to Labor Day.

Laborers (Tunnel Construction)

- a. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day. No employee shall be eligible for holiday pay when he fails, without cause, to work the regular work day preceding the holiday or the regular work day following the holiday.

Roofers

- a. Paid Holidays: July 4th, Labor Day, and Christmas Day provided the employee is employed 15 days prior to the holiday.

Sprinkler Fitters

- a. Paid Holidays: Memorial Day, July 4th, Labor Day, Thanksgiving Day and Christmas Day, provided the employee has been in the employment of a contractor 20 working days prior to any such paid holiday.

Truck Drivers

(Heavy and Highway Construction & Building Construction)

- a. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Christmas day, and Good Friday, provided the employee has at least 31 calendar days of service and works the last scheduled day before and the first scheduled day after the holiday, unless excused.

STATUTE 31-55a

- SPECIAL NOTICE -

To All State and Political Subdivisions, Their Agents, and Contractors Connecticut General Statute 31-55a - Annual adjustments to wage rates by contractors doing state work.

Each contractor that is awarded a contract on or after October 1, 2002, for (1) the construction of a state highway or bridge that falls under the provisions of section 31-54 of the general statutes, or (2) the construction, remodeling, refinishing, refurbishing, rehabilitation, alteration or repair of any public works project that falls under the provisions of section 31-53 of the general statutes shall contact the Labor Commissioner on or before July first of each year, for the duration of such contract, to ascertain the prevailing rate of wages on an hourly basis and the amount of payment or contributions paid or payable on behalf of each mechanic, laborer or worker employed upon the work contracted to be done, and shall make any necessary adjustments to such prevailing rate of wages and such payment or contributions paid or payable on behalf of each such employee, effective each July first.

- The prevailing wage rates applicable to any contract or subcontract awarded on or after October 1, 2002 are subject to annual adjustments each July 1st for the duration of any project which was originally advertised for bids on or after October 1, 2002.
- Each contractor affected by the above requirement shall pay the annual adjusted prevailing wage rate that is in effect each July 1st, as posted by the Department of Labor.
- It is the **contractor's** responsibility to obtain the annual adjusted prevailing wage rate increases directly from the Department of Labor's Web Site. The annual adjustments will be posted on the Department of Labor Web page: www.ctdol.state.ct.us. For those without internet access, please contact the division listed below.
- The Department of Labor will continue to issue the initial prevailing wage rate schedule to the Contracting Agency for the project. All subsequent annual adjustments will be posted on our Web Site for contractor access.

Any questions should be directed to the Contract Compliance Unit, Wage and Workplace Standards Division, Connecticut Department of Labor, 200 Folly Brook Blvd., Wethersfield, CT 06109 at (860)263-6790.

Information Bulletin

Occupational Classifications

The Connecticut Department of Labor has the responsibility to properly determine "job classification" on prevailing wage projects covered under C.G.S. Section 31-53(d).

Note: This information is intended to provide a sample of some occupational classifications for guidance purposes only. It is not an all-inclusive list of each occupation's duties. This list is being provided only to highlight some areas where a contractor may be unclear regarding the proper classification. If unsure, the employer should seek guidelines for CTDOL.

Below are additional clarifications of specific job duties performed for certain classifications:

- **ASBESTOS WORKERS**

Applies all insulating materials, protective coverings, coatings and finishes to all types of mechanical systems.

- **ASBESTOS INSULATOR**

Handle, install apply, fabricate, distribute, prepare, alter, repair, dismantle, heat and frost insulation, including penetration and fire stopping work on all penetration fire stop systems.

- **BOILERMAKERS**

Erects hydro plants, incomplete vessels, steel stacks, storage tanks for water, fuel, etc. Builds incomplete boilers, repairs heat exchanges and steam generators.

- **BRICKLAYERS, CEMENT MASONS, CEMENT FINISHERS, MARBLE MASONS, PLASTERERS, STONE MASONS, PLASTERERS. STONE MASONS, TERRAZZO WORKERS, TILE SETTERS**

Lays building materials such as brick, structural tile and concrete cinder, glass, gypsum, terra cotta block. Cuts, tools and sets marble, sets stone, finishes concrete, applies decorative steel, aluminum and plastic tile, applies cements, sand, pigment and marble chips to floors, stairways, etc.

- **CARPENTERS, MILLWRIGHTS. PILEDRIVERMEN. LATHERS. RESILIENT FLOOR LAYERS, DOCK BUILDERS, DIKERS, DIVER TENDERS**

Constructs, erects, installs and repairs structures and fixtures of wood, plywood and wallboard. Installs, assembles, dismantles, moves industrial machinery. Drives piling into ground to provide foundations for structures such as buildings and bridges, retaining walls for earth embankments, such as cofferdams. Fastens wooden, metal or rockboard lath to walls, ceilings and partitions of buildings, acoustical tile layer, concrete form builder. Applies firestopping materials on fire resistive joint systems only. Installation of curtain/window walls only where attached to wood or metal studs. Installation of insulated material of all types whether blown, nailed or attached in other ways to walls, ceilings and floors of buildings. Assembly and installation of modular furniture/furniture systems. Free-standing furniture is not covered. This includes free standing: student chairs, study top desks, book box desks, computer furniture, dictionary stand, atlas stand, wood shelving, two-position information access station, file cabinets, storage cabinets, tables, etc.

- **LABORER, CLEANING**

- The clean up of any construction debris and the general (heavy/light) cleaning, including sweeping, wash down, mopping, wiping of the construction facility and its furniture, washing, polishing, and dusting.

- **DELIVERY PERSONNEL**

- If delivery of supplies/building materials is to one common point and stockpiled there, prevailing wages are not required. If the delivery personnel are involved in the distribution of the material to multiple locations within the construction site then they would have to be paid prevailing wages for the type of work performed: laborer, equipment operator, electrician, ironworker, plumber, etc.

- An example of this would be where delivery of drywall is made to a building and the delivery personnel distribute the drywall from one "stockpile" location to further sub-locations on each floor. Distribution of material around a construction site is the job of a laborer or tradesman, and not a delivery personnel.

- **ELECTRICIANS**

Install, erect, maintenance, alteration or repair of any wire, cable, conduit, etc., which generates, transforms, transmits or uses electrical energy for light, heat, power or other purposes, including the Installation or maintenance of telecommunication, LAN wiring or computer equipment, and low voltage wiring. ****License required per Connecticut General Statutes: E-1,2 L-5,6 C-5,6 T-1,2 L-1,2 V-1,2,7,8,9.***

- **ELEVATOR CONSTRUCTORS**

Install, erect, maintenance and repair of all types of elevators, escalators, dumb waiters and moving walks. **License required by Connecticut General Statutes: R-1,2,5,6.*

- **FORK LIFT OPERATOR**

Laborers Group 4) Mason Tenders - operates forklift solely to assist a mason to a maximum height of nine (9) feet only.

Power Equipment Operator Group 9 - operates forklift to assist any trade, and to assist a mason to a height over nine (9) feet.

- **GLAZIERS**

Glazing wood and metal sash, doors, partitions, and 2 story aluminum storefronts. Installs glass windows, skylights, store fronts and display cases or surfaces such as building fronts, interior walls, ceilings and table tops and metal store fronts. Installation of aluminum window walls and curtain walls is the "joint" work of glaziers and ironworkers, which require equal composite workforce.

- **IRONWORKERS**

Erection, installation and placement of structural steel, precast concrete, miscellaneous iron, ornamental iron, metal curtain wall, rigging and reinforcing steel. Handling, sorting, and installation of reinforcing steel (rebar). Metal bridge rail (traffic), metal bridge handrail, and decorative security fence installation. Installation of aluminum window walls and curtain walls is the "joint" work of glaziers and ironworkers which require equal composite workforce.

- **INSULATOR**

- Installing fire stopping systems/materials for "Penetration Firestop Systems": transit to cables, electrical conduits, insulated pipes, sprinkler pipe penetrations, ductwork behind radiation, electrical cable trays, fire rated pipe penetrations, natural polypropylene, HVAC ducts, plumbing bare metal, telephone and communication wires, and boiler room ceilings.

- **LABORERS**

Acetylene burners, asphalt rakers, chain saw operators, concrete and power buggy operator, concrete saw operator, fence and guard rail erector (except metal bridge rail (traffic), decorative security fence (non-metal)).

installation.), hand operated concrete vibrator operator, mason tenders, pipelayers (installation of storm drainage or sewage lines on the street only), pneumatic drill operator, pneumatic gas and electric drill operator, powermen and wagon drill operator, air track operator, block paver, curb setters, blasters, concrete spreaders.

- **PAINTERS**

Maintenance, preparation, cleaning, blasting (water and sand, etc.), painting or application of any protective coatings of every description on all bridges and appurtenances of highways, roadways, and railroads. Painting, decorating, hardwood finishing, paper hanging, sign writing, scenic art work and drywall hhg for any and all types of building and residential work.

- **LEAD PAINT REMOVAL**

- Painter's Rate

1. Removal of lead paint from bridges.
2. Removal of lead paint as preparation of any surface to be repainted.
3. Where removal is on a Demolition project prior to reconstruction.

- Laborer's Rate

1. Removal of lead paint from any surface NOT to be repainted.
2. Where removal is on a *TOTAL* Demolition project only.

- **PLUMBERS AND PIPEFITTERS**

Installation, repair, replacement, alteration or maintenance of all plumbing, heating, cooling and piping. ****License required per Connecticut General Statutes: P-1,2,6,7,8,9 J-1,2,3,4 SP-1,2 S-1,2,3,4,5,6,7,8 B-1,2,3,4 D-1,2,3,4.***

- **POWER EQUIPMENT OPERATORS**

Operates several types of power construction equipment such as compressors, pumps, hoists, derricks, cranes, shovels, tractors, scrapers or motor graders, etc. Repairs and maintains equipment. ****License required, crane operators only, per Connecticut General Statutes.***

- **ROOFERS**

Covers roofs with composition shingles or sheets, wood shingles, slate or asphalt and gravel to waterproof roofs, including preparation of surface. (demolition or removal of any type of roofing and or clean-up of any and all areas where a roof is to be relaid.)

- **SHEETMETAL WORKERS**

Fabricate, assemble, install and repair sheetmetal products and equipment in such areas as ventilation, air-conditioning, warm air heating, restaurant equipment, architectural sheet metal work, sheetmetal roofing, and aluminum gutters. Fabrication, handling, assembling, erecting, altering, repairing, etc. of coated metal material panels and composite metal material panels when used on building exteriors and interiors as soffits, fascia, louvers, partitions, canopies, cornice, column covers, awnings, beam covers, cladding, sun shades, lighting troughs, spires, ornamental roofing, metal ceilings, mansards, copings, ornamental and ventilation hoods, vertical and horizontal siding panels, trim, etc. The sheet metal classification also applies to the vast variety of coated metal material panels and composite metal material panels that have evolved over the years as an alternative to conventional ferrous and non-ferrous metals like steel, iron, tin, copper, brass, bronze, aluminum, etc. Fabrication, handling, assembling, erecting, altering, repairing, etc. of architectural metal roof, standing seam roof, composite metal roof, metal and composite bathroom/toilet partitions, aluminum gutters, metal and composite lockers and shelving, kitchen equipment, and walk-in coolers. To include testing and air –balancing ancillary to installation and construction.

- **SPRINKLER FITTERS**

Installation, alteration, maintenance and repair of fire protection sprinkler systems.

****License required per Connecticut General Statutes: F-1,2,3,4.***

- **TILE MARBLE AND TERRAZZO FINISHERS**

Assists and tends the tile setter, marble mason and terrazzo worker in the performance of their duties.

- **TRUCK DRIVERS**

~How to pay truck drivers delivering asphalt is under REVISION~

Truck Drivers are required to be paid prevailing wage for time spent "working" directly on the site. These drivers remain covered by the prevailing wage for any time spent transporting between the actual construction location and facilities (such as fabrication, plants, mobile factories, batch plant, borrow pits, job headquarters, tool yards, etc.) dedicated exclusively, or nearly so, to performance of the contract or project, which are so located in proximity to the actual construction location that it is reasonable to include them. ****License required, drivers only, per Connecticut General Statutes.***

For example:

- Material men and deliverymen are not covered under prevailing wage as long as they are not directly involved in the construction process. If, they unload the material, they would then be covered by prevailing wage for the classification they are performing work in: laborer, equipment operator, etc.
- Hauling material off site is not covered provided they are not dumping it at a location outlined above.
- Driving a truck on site and moving equipment or materials on site would be considered covered work, as this is part of the construction process.

➤ *Any questions regarding the proper classification should be directed to:*
Public Contract Compliance Unit
Wage and Workplace Standards Division
Connecticut Department of Labor
200 Folly Brook Blvd, Wethersfield, CT 06109
(860) 263-6543.

Sec. 31-53b. Worker training requirements for public works projects. Enforcement.

Regulations. Exceptions. (a) Each contract for a public works project entered into on or after July 1, 2009, by the state or any of its agents, or by any political subdivision of the state or any of its agents, described in subsection (h) of section 31-53, shall contain a provision requiring that each contractor furnish proof with the weekly certified payroll form for the first week each employee begins work on such project that any person performing the work of a mechanic, laborer or worker pursuant to the classifications of labor under section 31-53 on such public works project, pursuant to such contract, has completed a course of at least ten hours in duration in construction safety and health approved by the federal Occupational Safety and Health Administration or, has completed a new miner training program approved by the Federal Mine Safety and Health Administration in accordance with 30 CFR 46 or, in the case of telecommunications employees, has completed at least ten hours of training in accordance with 29 CFR 1910.268, and on or after July 1, 2012, that any plumber or electrician subject to the continuing education requirements of section 20-334d, who has completed a course of at least ten hours in duration in construction safety and health approved by federal Occupational Safety and Health Administration five or more years prior to the date such electrician or plumber begins work on such public works project, has completed a supplemental refresher training course of at least four hours in duration in construction safety and health taught by a federal Occupational Safety and Health Administration authorized trainer.

(b) Any person required to complete a course or program under subsection (a) of this section who has not completed the course or program shall be subject to removal from the worksite if the person does not provide documentation of having completed such course or program by the fifteenth day after the date the person is found to be in noncompliance. The Labor Commissioner or said commissioner's designee shall enforce this section.

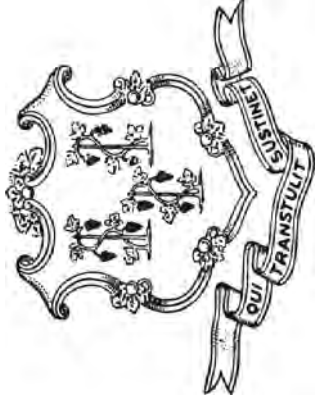
(c) Not later than January 1, 2012, the Labor Commissioner shall adopt regulations, in accordance with the provisions of chapter 54, to implement the provisions of subsections (a) and (b) of this section. Such regulations shall require that the ten-hour construction safety and health courses required under subsection (a) of this section be conducted in accordance with federal Occupational Safety and Health Administration Training Institute standards, or in the case of a supplemental refresher training course, shall include, but not be limited to, an update of revised Occupational Safety and Health Administration standards and a review of required construction hazards training, or in accordance with Federal Mine Safety and Health Administration Standards or in accordance with 29 CFR 1910.268, as appropriate. The Labor Commissioner shall accept as sufficient proof of compliance with the provisions of subsection (a) or (b) of this section a student course completion card issued by the federal Occupational Safety and Health Administration Training Institute, or such other proof of compliance said commissioner deems appropriate, dated no earlier than five years before the commencement date of such public works project or, in the case of supplemental refresher training, a student course completion card issued by said Occupational Safety and Health Administration authorized

trainer dated not earlier than five years prior to the date such electrician or plumber begins work on such public works project.

(d) This section shall not apply to employees of public service companies, as defined in section 16-1, or drivers of commercial motor vehicles driving the vehicle on the public works project and delivering or picking up cargo from public works projects provided they perform no labor relating to the project other than the loading and unloading of their cargo.

(P.A. 06-175, S. 1; P.A. 08-83, S. 1; P.A. 10-47, S. 2; P.A. 11-63, S. 1)

History: P.A. 08-83 amended Subsec. (a) by making provisions applicable to public works project contracts entered into on or after July 1, 2009, replacing provision re total cost of work with reference to Sec. 31-53(g), requiring proof in certified payroll form that new mechanic, laborer or worker has completed a 10-hour or more construction safety course and adding provision re new miner training program, amended Subsec. (b) by substituting "person" for "employee" and adding "or program", amended Subsec. (c) by adding "or in accordance with Federal Mine Safety and Health Administration Standards" and setting new deadline of January 1, 2009, deleted former Subsec. (d) re "public building", added new Subsec. (d) re exemptions for public service company employees and delivery drivers who perform no labor other than delivery and made conforming and technical changes, effective January 1, 2009; P.A. 10-47 made a technical change in Subsec. (a); P.A. 11-63 amended Subsec. (a) by adding provision re supplemental refresher training course for plumbers and electricians subject to Sec. 20-334d, amended Subsec. (c) by adding provisions re regulations and subject matter of refresher training course and refresher train course student completion cards, and made technical changes, effective July 1, 2011.



THIS IS A PUBLIC WORKS PROJECT

Covered by the

PREVAILING WAGE LAW

CT General Statutes Section 31-53

**If you have QUESTIONS regarding your wages
CALL (860) 263-6790**

Section 31-55 of the CT State Statutes requires every contractor or subcontractor performing work for the state to post in a prominent place the prevailing wages as determined by the Labor Commissioner.

Informational Bulletin

THE 10-HOUR OSHA CONSTRUCTION SAFETY AND HEALTH COURSE

(applicable to public building contracts entered into *on or after July 1, 2007*, where the total cost of all work to be performed is at least \$100,000)

- (1) This requirement was created by Public Act No. 06-175, which is codified in Section 31-53b of the Connecticut General Statutes (pertaining to the prevailing wage statutes);
- (2) The course is required for public building construction contracts (projects funded in whole or in part by the state or any political subdivision of the state) entered into on or after July 1, 2007;
- (3) It is required of private employees (not state or municipal employees) and apprentices who perform manual labor for a general contractor or subcontractor on a public building project where the total cost of all work to be performed is at least \$100,000;
- (4) The ten-hour construction course pertains to the ten-hour Outreach Course conducted in accordance with federal OSHA Training Institute standards, and, for telecommunications workers, a ten-hour training course conducted in accordance with federal OSHA standard, 29 CFR 1910.268;
- (5) The internet website for the federal OSHA Training Institute is http://www.osha.gov/fso/ote/training/edcenters/fact_sheet.html;
- (6) The statutory language leaves it to the contractor and its employees to determine who pays for the cost of the ten-hour Outreach Course;
- (7) Within 30 days of receiving a contract award, a general contractor must furnish proof to the Labor Commissioner that all employees and apprentices performing manual labor on the project will have completed such a course;
- (8) Proof of completion may be demonstrated through either: (a) the presentation of a *bona fide* student course completion card issued by the federal OSHA Training Institute; or (2) the presentation of documentation provided to an employee by a trainer certified by the Institute pending the actual issuance of the completion card;
- (9) Any card with an issuance date more than 5 years prior to the commencement date of the construction project shall not constitute proof of compliance;

- (10) Each employer shall affix a copy of the construction safety course completion card to the certified payroll submitted to the contracting agency in accordance with Conn. Gen. Stat. § 31-53(f) on which such employee's name first appears;
- (11) Any employee found to be in non-compliance shall be subject to removal from the worksite if such employee does not provide satisfactory proof of course completion to the Labor Commissioner by the fifteenth day after the date the employee is determined to be in noncompliance;
- (12) Any such employee who is determined to be in noncompliance may continue to work on a public building construction project for a maximum of fourteen consecutive calendar days while bringing his or her status into compliance;
- (13) The Labor Commissioner may make complaint to the prosecuting authorities regarding any employer or agent of the employer, or officer or agent of the corporation who files a false certified payroll with respect to the status of an employee who is performing manual labor on a public building construction project;
- (14) The statute provides the minimum standards required for the completion of a safety course by manual laborers on public construction contracts; any contractor can exceed these minimum requirements; and
- (15) Regulations clarifying the statute are currently in the regulatory process, and shall be posted on the CTDOL website as soon as they are adopted in final form.
- (16) Any questions regarding this statute may be directed to the Wage and Workplace Standards Division of the Connecticut Labor Department via the internet website of <http://www.ctdol.state.ct.us/wgwkstnd/wgemenu.htm>; or by telephone at (860)263-6790.

THE ABOVE INFORMATION IS PROVIDED EXCLUSIVELY AS AN EDUCATIONAL RESOURCE, AND IS NOT INTENDED AS A SUBSTITUTE FOR LEGAL INTERPRETATIONS WHICH MAY ULTIMATELY ARISE CONCERNING THE CONSTRUCTION OF THE STATUTE OR THE REGULATIONS.

November 29, 2006

Notice
To All Mason Contractors and Interested Parties
Regarding Construction Pursuant to Section 31-53 of the
Connecticut General Statutes (Prevailing Wage)

The Connecticut Labor Department Wage and Workplace Standards Division is empowered to enforce the prevailing wage rates on projects covered by the above referenced statute.

Over the past few years the Division has withheld enforcement of the rate in effect for workers who operate a forklift on a prevailing wage rate project due to a potential jurisdictional dispute.

The rate listed in the schedules and in our Occupational Bulletin (see enclosed) has been as follows:

Forklift Operator:

- **Laborers (Group 4) Mason Tenders** - operates forklift solely to assist a mason to a maximum height of nine feet only.
- **Power Equipment Operator (Group 9)** - operates forklift to assist any trade and to assist a mason to a height over nine feet.

The U.S. Labor Department conducted a survey of rates in Connecticut but it has not been published and the rate in effect remains as outlined in the above Occupational Bulletin.

Since this is a classification matter and not one of jurisdiction, effective January 1, 2007 the Connecticut Labor Department will enforce the rate on each schedule in accordance with our statutory authority.

Your cooperation in filing appropriate and accurate certified payrolls is appreciated.

NOTICE

TO ALL CONTRACTING AGENCIES

Please be advised that Connecticut General Statutes Section 31-53, requires the contracting agency to certify to the Department of Labor, the total dollar amount of work to be done in connection with such public works project, regardless of whether such project consists of one or more contracts.

Please find the attached “Contracting Agency Certification Form” to be completed and returned to the Department of Labor, Wage and Workplace Standards Division, Public Contract Compliance Unit.

Inquiries can be directed to 860.263.6790.



CONNECTICUT DEPARTMENT OF LABOR
WAGE AND WORKPLACE STANDARDS DIVISION

Contracting Agency Certification Form

I, _____, acting in my official capacity as _____,
Authorized Representative Title
for _____, located at _____,
Contracting Agency Address

do hereby certify that the total dollar amount of work to be done in connection with

_____, located at _____,
Project name and number Address

shall be \$_____, which includes all work, regardless of whether such project
contains of one or more contracts.

Contractor Information

Name: _____

Address: _____

Authorized Representative: _____

Approximate Starting Date: _____

Approximate Completion Date: _____

Signature

Date

Return to:

Connecticut Department of Labor
Wage & Workplace Standards Division
200 Folly Brook Blvd.
Wethersfield, CT 06109

Rate Schedule Issued (Date): _____

[New] In accordance with Section 31-53b(a) of the C.G.S. each contractor shall provide a copy of the OSHA 10 Hour Construction Safety and Health Card for each employee, to be attached to the first certified payroll on the project.

PAYROLL CERTIFICATION FOR PUBLIC WORKS PROJECTS

In accordance with Connecticut General Statutes, 31-53 Certified Payrolls with a statement of compliance shall be submitted monthly to the contracting agency.

**Connecticut Department of Labor
Wage and Workplace Standards Division
200 Folly Brook Blvd.
Wethersfield, CT 06109**

WEEKLY PAYROLL

CONTRACTOR NAME AND ADDRESS:										SUBCONTRACTOR NAME & ADDRESS										WORKER'S COMPENSATION INSURANCE CARRIER			
PAYROLL NUMBER		Week-Ending Date		PROJECT NAME & ADDRESS										POLICY # EFFECTIVE DATE: EXPIRATION DATE:									
PERSON/WORKER, ADDRESS and SECTION	APPR RATE %	MALE/FEMALE AND RACE*	WORK CLASSIFICATION Trade License Type & Number - OSHA 10 Certification Number	DAY AND DATE							Total ST Hours	Total O/T Hours	BASE HOURLY RATE	TYPE OF FRINGE BENEFITS Per Hour 1 through 6 (see back)	GROSS PAY FOR ALL WORK PERFORMED THIS WEEK	TOTAL DEDUCTIONS			GROSS PAY FOR THIS PREVAILING RATE JOB	CHECK # AND NET PAY			
				S	M	T	W	TH	F	S						FICA	WITH- HOLDING	LIST OTHER					
				HOURS WORKED EACH DAY																			

***FRINGE BENEFITS EXPLANATION (P):**

Bona fide benefits paid to approved plans, funds or programs, except those required by Federal or State Law (unemployment tax, worker's compensation, income taxes, etc.).

Please specify the type of benefits provided:

- 1) Medical or hospital care _____ 4) Disability _____
2) Pension or retirement _____ 5) Vacation, holiday _____
3) Life Insurance _____ 6) Other (please specify) _____

CERTIFIED STATEMENT OF COMPLIANCE

For the week ending date of _____,

I, _____ of _____, (hereafter known as

Employer) in my capacity as _____ (title) do hereby certify and state:

Section A:

1. All persons employed on said project have been paid the full weekly wages earned by them during the week in accordance with Connecticut General Statutes, section 31-53, as amended. Further, I hereby certify and state the following:

- a) The records submitted are true and accurate;
- b) The rate of wages paid to each mechanic, laborer or workman and the amount of payment or contributions paid or payable on behalf of each such employee to any employee welfare fund, as defined in Connecticut General Statutes, section 31-53 (h), are not less than the prevailing rate of wages and the amount of payment or contributions paid or payable on behalf of each such employee to any employee welfare fund, as determined by the Labor Commissioner pursuant to subsection Connecticut General Statutes, section 31-53 (d), and said wages and benefits are not less than those which may also be required by contract;
- c) The Employer has complied with all of the provisions in Connecticut General Statutes, section 31-53 (and Section 31-54 if applicable for state highway construction);
- d) Each such employee of the Employer is covered by a worker's compensation insurance policy for the duration of his employment which proof of coverage has been provided to the contracting agency;
- e) The Employer does not receive kickbacks, which means any money, fee, commission, credit, gift, gratuity, thing of value, or compensation of any kind which is provided directly or indirectly, to any prime contractor, prime contractor employee, subcontractor, or subcontractor employee for the purpose of improperly obtaining or rewarding favorable treatment in connection with a prime contract or in connection with a prime contractor in connection with a subcontractor relating to a prime contractor; and
- f) The Employer is aware that filing a certified payroll which he knows to be false is a class D felony for which the employer may be fined up to five thousand dollars, imprisoned for up to five years or both.

2. OSHA~The employer shall affix a copy of the construction safety course, program or training completion document to the certified payroll required to be submitted to the contracting agency for this project on which such employee's name first appears.

(Signature) (Title) Submitted on (Date)

Section B: Applies to CONNDOT Projects ONLY

That pursuant to CONNDOT contract requirements for reporting purposes only, all employees listed under Section B who performed work on this project are not covered under the prevailing wage requirements defined in Connecticut General Statutes Section 31-53.

(Signature) (Title) Submitted on (Date)

Note: CTDOL will assume all hours worked were performed under Section A unless clearly delineated as Section B WWS-CP1 as such. Should an employee perform work under both Section A and Section B, the hours worked and wages paid must be segregated for reporting purposes.

*****THIS IS A PUBLIC DOCUMENT*****

*****DO NOT INCLUDE SOCIAL SECURITY NUMBERS*****

**Weekly Payroll Certification For
Public Works Projects (Continued)**

PAYROLL CERTIFICATION FOR PUBLIC WORKS PROJECTS

Week-Ending Date: _____
Contractor or Subcontractor Business Name: _____

WEEKLY PAYROLL

PERSON/WORKER, ADDRESS and SECTION	APPR RATE %	MALE/ FEMALE AND RACE*	WORK CLASSIFICATION	DAY AND DATE							Total ST Hours	BASE HOURLY RATE		TYPE OF FRINGE BENEFITS Per Hour 1 through 6 (see back)	GROSS PAY FOR ALL WORK PERFORMED THIS WEEK	TOTAL DEDUCTIONS			GROSS PAY FOR THIS PREVAILING RATE JOB	CHECK # AND NET PAY
				S	M	T	W	TH	F	S		TOTAL FRINGE BENEFIT PLAN CASH	FICA WITH- HOLDING			FEDERAL STATE	LIST OTHER			
HOURS WORKED EACH DAY																				
												\$	1. \$							
												Base Rate	2. \$							
												\$	3. \$							
												Cash Fringe	4. \$							
												\$	5. \$							
												Cash Fringe	6. \$							
												\$	1. \$							
												Base Rate	2. \$							
												\$	3. \$							
												Cash Fringe	4. \$							
												\$	5. \$							
												Cash Fringe	6. \$							
												\$	1. \$							
												Base Rate	2. \$							
												\$	3. \$							
												Cash Fringe	4. \$							
												\$	5. \$							
												Cash Fringe	6. \$							

*IF REQUIRED

Amity Regional School District No. 5 2025-2026 District Calendar



Date	Event or Holiday
August 19	Prof. Dev. - Teachers Only
August 20	Prof. Dev. - Teachers Only
August 21	Prof. Dev. - Teachers Only
August 25	1st Day of School - Students <i>Early Dismissal</i>
August 26	Students <i>Early Dismissal</i>
September 1	Labor Day - No School
September 4	Back to School Night - ARHS - Grades 9&12
September 9	Back to School Night - Middle Schools
September 10	Back to School Night - ARHS - Grades 10&11
September 18	<i>Early Dismissal</i> - Professional Learning
September 23	Rosh Hashanah - No School
October 2	Yom Kippur - No School
October 13	Columbus/Indigenous Peoples - No School
October 16	<i>Early Dismissal</i> - Professional Learning
October 20	Diwali - No School
November 4	Prof. Dev. - Teachers Only
November 5	Parent Conferences - Middle Schools
November 6	Parent Conferences - High School
November 12	Parent Conferences - High School
November 13	Parent Conferences - Middle Schools
November 26	<i>Early Dismissal</i>
November 27, 28	Thanksgiving - No School
December 3	Parent Conferences - MS/HS - <i>Early Dismissal</i>
December 4	<i>Early Dismissal</i> - Professional Learning
December 23	<i>Early Dismissal</i>
December 24 - January 2	Holiday Recess - No School
January 8	<i>Early Dismissal</i> - Professional Learning
January 19	Martin Luther King, Jr. Day - No School
February 4	Parent Conferences - Middle Schools
February 5	<i>Early Dismissal</i> - Professional Learning
February 10	Parent Conferences - Middle Schools
February 11	Parent Conferences - High School
February 13 - 17	Winter Recess - No School
March 12	<i>Early Dismissal</i> - Professional Learning
March 20	Eid al-Fitr - No School
April 3	Good Friday - No School
April 13-17	Spring Recess - No School
April 23	<i>Early Dismissal</i> - Professional Learning
May 25	Memorial Day - No School
June 11	Graduation - Class of 2026
June 17	Last Day of School - Students

August 2025 (5/5)							September 2025 (20/25)							October 2025 (20/45)						
S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S
						1	31	1	2	3	4	5	6				1	2	3	4
3	4	5	6	7	8	9	7	8	9	10	11	12	13	5	6	7	8	9	10	11
10	11	12	13	14	15	16	14	15	16	17	18	19	20	12	13	14	15	16	17	18
17	18	19	20	21	22	23	21	22	23	24	25	26	27	19	20	21	22	23	24	25
24	25	26	27	28	29	30	28	29	30					26	27	28	29	30	31	

November 2025 (17/62)							December 2025 (17/79)							January 2026 (19/98)						
S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S
						1														
2	3	4	5	6	7	8	7	8	9	10	11	12	13	4	5	6	7	8	9	10
9	10	11	12	13	14	15	14	15	16	17	18	19	20	11	12	13	14	15	16	17
16	17	18	19	20	21	22	21	22	23	24	25	26	27	18	19	20	21	22	23	24
23	24	25	26	27	28	29	28	29	30	31				25	26	27	28	29	30	31
30																				

February 2026 (17/115)							March 2026 (21/136)							April 2026 (16/152)						
S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S
1	2	3	4	5	6	7	1	2	3	4	5	6	7							
8	9	10	11	12	13	14	8	9	10	11	12	13	14	5	6	7	8	9	10	11
15	16	17	18	19	20	21	15	16	17	18	19	20	21	12	13	14	15	16	17	18
22	23	24	25	26	27	28	22	23	24	25	26	27	28	19	20	21	22	23	24	25
							29	30	31					26	27	28	29	30		

May 2026 (20/172)							June 2026 (9/181)							July 2026 (0)						
S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S
						1														
3	4	5	6	7	8	9	7	8	9	10	11	12	13							
10	11	12	13	14	15	16	14	15	16	17	18	19	20	5	6	7	8	9	10	11
17	18	19	20	21	22	23	21	22	23	24	25	26	27	12	13	14	15	16	17	18
24	25	26	27	28	29	30	28	29	30					19	20	21	22	23	24	25
31														26	27	28	29	30	31	

If emergency closings extend beyond June 30, 2026, then any additional days will be taken from Spring Recess; beginning with April 13, 2026. Amity Regional High School Graduation is traditionally held on the actual last day of school for students. Total Days For Students = 181; Total Days For Teachers = 185

Amity Regional School District No. 5

2026-2027 District Calendar



Date	Event or Holiday
August 25	Prof. Dev. - Teachers Only
August 26	Prof. Dev. - Teachers Only
August 27	Prof. Dev. - Teachers Only
August 31	1st Day of School - Students <i>Early Dismissal</i>
September 1	Students <i>Early Dismissal</i>
September 7	Labor Day - No School
September 10	Back to School Night - ARHS - Grades 9&12
September 15	Back to School Night - Middle Schools
September 16	Back to School Night - ARHS - Grades 10&11
September 17	<i>Early Dismissal</i> - Professional Learning
September 21	Yom Kippur - No School
October 12	Columbus/Indigenous Peoples - No School
October 22	<i>Early Dismissal</i> - Professional Learning
November 3	Prof. Dev. - Teachers Only
November 4	Parent Conferences - Middle Schools
November 5	Parent Conferences - High School
November 11	Parent Conferences - High School
November 12	Parent Conferences - Middle Schools
November 25	<i>Early Dismissal</i>
November 26, 27	Thanksgiving - No School
December 2	Parent Conferences - MS/HS - <i>Early Dismissal</i>
December 10	<i>Early Dismissal</i> - Professional Learning
December 23	<i>Early Dismissal</i>
December 24 - January 1	Holiday Recess - No School
January 7	<i>Early Dismissal</i> - Professional Learning
January 18	Martin Luther King, Jr. Day - No School
February 3	Parent Conferences - Middle Schools
February 4	<i>Early Dismissal</i> - Professional Learning
February 9	Parent Conferences - Middle Schools
February 12 - 16	Winter Recess - No School
February 24	Parent Conferences - High School
March 10	Eid al-Fitr - No School
March 18	<i>Early Dismissal</i> - Professional Learning
March 26	Good Friday - No School
April 12-16	Spring Recess - No School
April 22	<i>Early Dismissal</i> - Professional Learning
May 31	Memorial Day - No School
June 14	Last Day of School - Students

August 2026 (1/1)							September 2026 (20/21)							October 2026 (21/42)						
S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S
						1														
2	3	4	5	6	7	8	6	7	8	9	10	11	12	4	5	6	7	8	9	10
9	10	11	12	13	14	15	13	14	15	16	17	18	19	11	12	13	14	15	16	17
16	17	18	19	20	21	22	20	21	22	23	24	25	26	18	19	20	21	22	23	24
23	24	25	26	27	28	29	27	28	29	30				25	26	27	28	29	30	31
30	31																			

November 2026 (18/60)							December 2026 (17/77)							January 2027 (19/96)						
S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S
1	2	3	4	5	6	7	6	7	8	9	10	11	12	3	4	5	6	7	8	9
8	9	10	11	12	13	14	13	14	15	16	17	18	19	10	11	12	13	14	15	16
15	16	17	18	19	20	21	20	21	22	23	24	25	26	17	18	19	20	21	22	23
22	23	24	25	26	27	28	27	28	29	30	31			24	25	26	27	28	29	30
29	30													31						

February 2027 (17/113)							March 2027 (21/134)							April 2027 (17/151)						
S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S
1	2	3	4	5	6		1	2	3	4	5	6								
7	8	9	10	11	12	13	7	8	9	10	11	12	13	4	5	6	7	8	9	10
14	15	16	17	18	19	20	14	15	16	17	18	19	20	11	12	13	14	15	16	17
21	22	23	24	25	26	27	21	22	23	24	25	26	27	18	19	20	21	22	23	24
28							28	29	30	31				25	26	27	28	29	30	

May 2027 (20/171)							June 2027 (10/181)							July 2027 (0)						
S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S
						1														
2	3	4	5	6	7	8	6	7	8	9	10	11	12	4	5	6	7	8	9	10
9	10	11	12	13	14	15	13	14	15	16	17	18	19	11	12	13	14	15	16	17
16	17	18	19	20	21	22	20	21	22	23	24	25	26	18	19	20	21	22	23	24
23	24	25	26	27	28	29	27	28	29	30				25	26	27	28	29	30	31
30	31																			

If emergency closings extend beyond June 30, 2027, then any additional days will be taken from Spring Recess, beginning with April 12, 2027. Amity Regional High School Graduation is traditionally held on the actual last day of school for students. Total Days For Students = 181; Total Days For Teachers = 185

MEDIA CENTER INTERIOR ALTERATIONS

**AMITY REGIONAL HIGH SCHOOL
25 NEWTON ROAD
WOODBIDGE, CT 06525
STATE PROJECT #205-0046 A
BID #2026-LMC-HS-1**

S/P+A PROJECT #23.195

Drawing NumberDrawing Name

COVER SHEET

GENERAL DRAWINGS

G001 GENERAL INFORMATION & DRAWING LIST
G002 BUILDING CODE PLAN & INFORMATION, PARTITION TYPES

STRUCTURAL DRAWINGS

S112 PARTIAL ROOF FRAMING PLAN

ARCHITECTURAL DRAWINGS

A011 PARTIAL 1ST FLOOR DEMOLITION PLAN – MEDIA CENTER
A012-A020 NOT USED
A021 PARTIAL 1ST FLOOR DEMOLITION RCP – MEDIA CENTER
A022-A110 NOT USED
A111 PARTIAL 1ST FLOOR NEW WORK PLAN – MEDIA CENTER
A112 PARTIAL ROOF PLAN
A113-A210 NOT USED
A211 PARTIAL 1ST FLOOR FINISH PLAN & SCHEDULE – MEDIA CENTER
A212-230 NOT USED
A231 PARTIAL 1ST FLOOR FF&E PLAN – MEDIA CENTER (FOR REF ONLY)
A232-A250 NOT USED
A251 PARTIAL 1ST FLOOR CEILING PLAN – MEDIA CENTER
A252-A259 NOT USED
A260 CEILING DETAILS
A261-A599 NOT USED
A600 WINDOW ELEVATIONS & DETAILS
A601-A704 NOT USED
A705 ENLARGED PARTIAL PLANS
A706-A729 NOT USED
A730-A737 INTERIOR ELEVATIONS
A738-A799 NOT USED
A800 CASEWORK DETAILS
A801-A929 NOT USED
A930 DOOR DETAILS & SCHEDULE, SIGNAGE

FIRE PROTECTION DRAWINGS

FP001 FP GENERAL NOTES, ABBREVIATIONS & LEGENDS
FP002-FP009 NOT USED
FP010 FP FIRST FLOOR DEMO PLAN
FP011-FP109 NOT USED
FP110 FP FIRST FLOOR PLAN
FP111-FP499 NOT USED

FP500 FP SCHEDULES & DETAILS

PLUMBING DRAWINGS

P001 PLUMB GENERAL NOTES, ABBREVIATIONS & LEGENDS
P002-P009 NOT USED
P010 PLUMB FIRST FLOOR DEMO PLAN
P011-P099 NOT USED
P100 PLUMB FIRST FLOOR PLAN

MECHANICAL DRAWINGS

M001 MECHANICAL GENERAL NOTES, ABBREVIATIONS & LEGENDS
M002-M010 NOT USED
M011 MECH FIRST FLOOR DEMO PLAN
M012-M110 NOT USED
M111 MECH FIRST FLOOR DUCT PLAN
M112 MECH ROOF DUCT PLAN
M113-M210 NOT USED
M211 MECH FIRST FLOOR PIPING PLAN
M212 MECH ROOF PIPING PLAN
M213-M499 NOT USED
M500-M501 MECHANICAL SCHEDULES
M502-M599 NOT USED
M600-M602 MECH DETAILS

MECHANICAL AS-BUILT DRAWINGS (FOR REFERENCE ONLY)

SM-A-1.1-SM-A-1.2 PART 'A' 1ST FLOOR HVAC PLAN
SM-A-2.1-SM-A-2.2 PART 'A' 2ND FLOOR HVAC PLAN
SM-B-1.1-SM-B-1.2 PART 'B' 1ST FLOOR HVAC PLAN
SM-B-2.2 PART 'B' 2ND FLOOR HVAC PLAN

ELECTRICAL DRAWINGS

E001 GENERAL NOTES, ABBREVIATIONS & LEGENDS
E002-E010 NOT USED
E011 FIRST FLOOR DEMOLITION PLAN – LIGHTING
E012-E020 NOT USED
E021 FIRST FLOOR DEMOLITION PLAN – POWER
E022-E110 NOT USED
E111 FIRST FLOOR PLAN – LIGHTING
E112-E210 NOT USED
E211 FIRST FLOOR PLAN – POWER
E212 SECOND FLOOR/ROOF PLAN – POWER
E213-E400 NOT USED
E401 PARTIAL ONE LINE DIAGRAM & PANEL SCHEDULES
E402-E500 NOT USED
E501 LIGHT FIXTURE SCHEDULE & DETAILS

TECHNOLOGY DRAWINGS

T001 SYMBOLS, NOTES, ABBREVIATIONS & DRAWING LIST
T002-T010 NOT USED
T011 FIRST FLOOR DEMOLITION PLAN
T012-T110 NOT USED
T111 FIRST FLOOR PLAN
T112-T600 NOT USED
T601 TECH DETAILS

END OF SECTION

SECTION 011000 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 PROJECT DESCRIPTION

- A. The Work of the Project is defined by the Contract Documents and consists of the interior alterations of a media center at an existing school including all associated fire protection, mechanical, and electrical work, as well as the provision and installation of a dedicated rooftop unit.

1.3 CONTRACTOR USE OF PREMISES

- A. Limits on Use of Site: Limit use of the premises to construction activities in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
- B. Confine operations to as small work areas and accessways as possible. As much as possible and without damage to the finishes, doors, and related building systems, access the project area via the service doors designated by Owner.
- C. Keep driveways and entrances serving the premises clear and available to the Owner and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.
- D. Maintain existing egress patterns, exit doors, and means of egress during construction, which will include the provision of temporary walkways, sidewalks, or other means necessary to provide adequate life safety for the building occupants, particularly at exitways which must continue to be open and serviceable while adjacent construction activity occurs.
- E. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.
 - 1. Contractor is responsible to secure project area/site from intrusions during unoccupied (after hours) period of time. Any temporary doors and/or window coverings that may be necessary to complete repairs are the Contractors responsibility to furnish and install as part of the project scope.

1.4 OWNER OCCUPANCY

- A. Full Owner Occupancy: The Owner's administrative and maintenance staff will occupy the site and existing building during the entire construction period, with children on site during the school year. Cooperate with the Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with the Owner's operations. Pre-schedule construction operations with the Owner for areas that must be evacuated for extended periods, giving the Owner the opportunity to relocate administrative or educational operations to non-affected areas.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

1.5 SPECIAL REQUIREMENTS

- A. The Contractor shall ensure that all work performed is done so in a safe manner and that all his/her employees shall adhere to all applicable safety procedures and practices at all times. There may be children and staff in the vicinity of the work area during normal working hours. The Contractor shall be aware at all times that additional safety considerations should be taken. Particular care shall be taken by the Contractor, Subcontractors and all those in their employ, that all tools, equipment, ladders, etc. are never left unsupervised.
- B. Meaningful Instruction: Meaningful instruction (as determined by the Owner) must be facilitated and possible within the building at all times. This requirement may limit the Contractor's demolition and construction operations as the distraction represented by hammering, material movement, etc. may disrupt classes. No down time or mobilization charges will be permitted should the meaningful instruction requirement suspend the Contractor's operations for any length of time.
- C. Testing: During the school year, Smarter Balanced Assessment Consortium may be administered to portions of the student population, which requires absolute concentration on the part of the students. The Owner may prohibit operations during the administration of these assessments. Cooperate with the Owner to determine the schedule, locations of the testing and where operations may proceed with disrupting classroom or roofing operations.
- D. Under no circumstances shall the buildings' occupants be subjected to excessive construction noise or vibrations, nor shall they be subject to fumes, odors, or other deleterious effects of the operation. Should material delivery, demolition or construction operations, inclement weather, or related schedule conditions produce this situation (as determined by the Owner), the Contractor shall be required to suspend operations that produce the offending effects until such time as the building is not occupied, or as approved by the Owner.
- E. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances inside the building or on the grounds is not permitted. Strict adherence to the regulations will be enforced for the entire duration of the construction.
- F. There will be absolutely **no** fraternizing with the students by construction personnel. Anyone caught doing so will be required to leave the jobsite and will not be permitted to return. Such dismissal shall not give the contractor grounds for default on any other contract requirements, including the construction schedule.
- G. Site Security – Identification Badges
 1. The Contractor shall provide a list of all contact persons. The list shall include each trade, name of Contractor, contact person(s), phone numbers, fax numbers, Federal Employer Identification Number (FEIN), social security number if FEIN is not available, and Connecticut Tax Registration number.
 2. Prior to the start of work all Contractor and Sub-Contractor personnel assigned to perform work shall be required to fill out and submit to a background check at a cost provided by the Contractor. All information shall be submitted to Amity Regional School District 5. Information for background check includes the following:

- a. Identity Verification
 - b. Criminal Background
 - c. Additional checks as deemed warranted.
 - 3. Security badges will be worn by all project personnel during construction activities. The Contractor will provide badges at no cost to the Owner. The Contractor will be responsible for monitoring the display of badges, including those of the personnel of all subcontractors and visitors to the project site.
- H. Public Health Emergency:
- 1. The Contractor shall anticipate and incorporate in their Bids all potential costs related to a public health emergency such as the COVID-19/Coronavirus Pandemic, including rules, regulations, and recommendations issued by public authorities. The potential costs may include, but are not limited to, costs related to social distancing, manpower levels, project scheduling, construction coordination, material/product supplies and delivery delays, material escalation costs, increased subcontractor/supplier costs, loss of productivity and inefficiency costs, extended general conditions costs, and any other potential costs.
- I. Overtime: The Contractor must include within their Base Bid all overtime, nights, holidays, and weekends as required to meet the Project Completion date.
- J. Supervision: The Contractor must provide full-time, properly qualified on-site supervision for the entire duration of the project, while workpersons are on site.
- K. Equipment: All equipment and tools to perform work are to be provided by the Contractor. No equipment and tools will be available from the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Sections:
 - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
 - 2. Divisions 02 through 49 Sections for specific requirements and limitations for substitutions.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 SUBMITTALS

- A. Substitution Requests: Submit three (3) copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use **CSI Form 1.5C, 13.1A**, or comparable form.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed, SIDE-BY-SIDE comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of Architects and Owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven (7) days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. Coordination: Modify or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Procurement Substitution Request: Submit to Architect seven (7) days prior to date of bid opening.

- B. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than fifteen (15) days prior to time required for preparation and review of related submittals.
1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one (1) contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- C. Substitutions for Convenience: Architect will consider requests for substitution if received within sixty (60) days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.
1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Substitution request is fully documented and properly submitted.
 - e. Requested substitution will not adversely affect Contractor's construction schedule.
 - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - g. Requested substitution is compatible with other portions of the Work.
 - h. Requested substitution has been coordinated with other portions of the Work.
 - i. Requested substitution provides specified warranty.
 - j. If requested substitution involves more than one (1) contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Sections:
 - 1. Section 016000 "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions."

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request or twenty (20) days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - e. Quotation Form: Use forms acceptable to Architect.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to the Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form acceptable to Architect.

1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Sections:
 - 1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.
 - 3. Section 013300 "Submittal Procedures" for administrative requirements governing the preparation and submittal of the submittal schedule.

1.3 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Correlate line items in the schedule of values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with continuation sheets.
 - b. Submittal schedule.
 - c. Items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect at earliest possible date but no later than seven (7) days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one (1) line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 - 2. Arrange schedule of values consistent with format of AIA Document G703.
 - 3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project

- Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent (5%) of Contract Sum.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
 5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.
 6. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
 7. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
 8. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.4 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 or comparable form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
 5. Include updated and approved Contractor's construction schedule, potential Change Order Log and Product Submittal Log.

- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Materials previously stored and included in previous Applications for Payment.
 - b. Work completed for this Application utilizing previously stored materials.
 - c. Additional materials stored with this Application.
 - d. Total materials remaining stored, including materials with this Application.
- F. Transmittal: Submit three (3) signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One (1) copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.
- H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Products list (preliminary if not final).
 5. Submittal schedule (preliminary if not final).
 6. List of Contractor's staff assignments.
 7. List of Contractor's principal consultants.
 8. Copies of building permits.
 9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 10. Initial progress report.
 11. Report of pre-construction conference.
 12. Certificates of insurance and insurance policies.
 13. Performance and payment bonds.
 14. Data needed to acquire Owner's insurance.

- I. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing one hundred percent (100%) completion for portion of the Work claimed as substantially complete.
 1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- J. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
 1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
 5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
 6. AIA Document G707, "Consent of Surety to Final Payment."
 7. Evidence that claims have been settled.
 8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

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 administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Administrative and supervisory personnel.
 - 3. Coordination drawings.
 - 4. Requests for Information (RFIs).
 - 5. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Sections:
 - 1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

- A. RFI: Request from Owner, Architect, or Contractor seeking information from each other during construction.

1.4 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one (1) part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate Contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Pre-installation conferences.
 7. Startup and adjustment of systems.
 8. Project closeout activities.
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings in accordance with requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one (1) entity.
 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Indicate required installation sequences.
 - f. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements and mechanical, plumbing, fire protection, fire alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire protection, fire alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Mechanical Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts, and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
6. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1¼-inch-diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire alarm locations.
 - c. Location of pull boxes and junction boxes, dimensioned from column center lines.
7. Fire Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
8. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor's responsibility. If the Architect determines that the coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, the Architect will so inform the Contractor, who shall make changes as directed and resubmit.
9. Coordination Drawing Prints: Prepare coordination drawing prints in accordance with requirements of Section 013300 "Submittal Procedures."

1.6 KEY PERSONNEL

- A. Key Personnel Names: Within fifteen (15) days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
 1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.7 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
 - 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 - 1. Project name.
 - 2. Project number.
 - 3. Date.
 - 4. Name of Contractor.
 - 5. Name of Architect.
 - 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 solution(s) 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: AIA Document G716 or comparable form.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven (7) 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 RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for coordination information already indicated in the Contract Documents.
 - d. Requests for adjustments in the Contract Time or the Contract Sum.
 - e. Requests for interpretation of Architect's actions on submittals.
 - f. Incomplete RFIs or 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 of additional information.
 - 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

- a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within ten (10) days of receipt of the RFI response.
- E. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven (7) days if Contractor disagrees with response.
- F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:
 - 1. Project name.
 - 2. Name and address of Contractor.
 - 3. Name and address of Architect.
 - 4. RFI number including RFIs that were dropped and not submitted.
 - 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.

1.8 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
 - 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 - 3. Minutes: General Contractor or Construction Manager is responsible for recording significant discussions and agreements achieved. General Contractor or Construction Manager is also responsible for distributing the meeting minutes to everyone concerned including Owner and Architect, within three (3) days of the meeting.
- B. Pre-construction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than fifteen (15) days after execution of the Agreement.
 - 1. Conduct the conference to review responsibilities and personnel assignments.
 - 2. Attendees: Authorized representatives of Owner, Construction Administrator, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.

- j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Preparation of record documents.
 - m. Work restrictions.
 - n. Working hours.
 - o. Owner's occupancy requirements.
 - p. Responsibility for temporary facilities and controls.
 - q. Procedures for moisture and mold control.
 - r. Procedures for disruptions and shutdowns.
 - s. Parking availability.
 - t. Office, work, and storage areas.
 - u. Equipment deliveries and priorities.
 - v. First aid.
 - w. Security.
 - x. Progress cleaning.
4. Minutes: General Contractor or Construction Manager is responsible for recording and distributing meeting minutes.
- C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
 - 2. Agenda: Review of the progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Possible conflicts.
 - i. Compatibility problems.
 - j. Time schedules.
 - k. Weather limitations.
 - l. Manufacturer's written recommendations.
 - m. Warranty requirements.
 - n. Compatibility of materials.
 - o. Acceptability of substrates.
 - p. Temporary facilities and controls.
 - q. Space and access limitations.
 - r. Regulations of authorities having jurisdiction.
 - s. Testing and inspecting requirements.
 - t. Installation procedures.
 - u. Coordination with other work.
 - v. Required performance results.
 - w. Protection of adjacent work.
 - x. Protection of construction and personnel.
 - 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a Project closeout conference, at a time convenient to Owner and Architect, but no later than thirty (30) days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for preparing operations and maintenance data.
 - e. Requirements for demonstration and training.
 - f. Preparation of Contractor's punch list.
 - g. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - h. Submittal procedures.
 - i. Responsibility for removing temporary facilities and controls.
 4. Minutes: General Contractor or Construction Manager is responsible for recording and distributing meeting minutes.
- E. Progress Meetings: Conduct progress meetings at bi-weekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner and Architect, each Contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.

- b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
- 4. Minutes: General Contractor or Construction Manager is responsible for recording and distributing meeting minutes.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Conduct Project coordination meetings at required intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.
 - 1. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.

- 8) Temporary facilities and controls.
- 9) Work hours.
- 10) Hazards and risks.
- 11) Progress cleaning.
- 12) Quality and work standards.
- 13) Change Orders.

- 2. Reporting: The General Contractor or Construction Manager is responsible for recording meeting results and distributing copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

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 administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Contractor's construction schedule.
 - 2. Daily construction reports.
 - 3. Material location reports.
 - 4. Field condition reports.
 - 5. Special reports.
- B. Related Sections:
 - 1. Section 013300 "Submittal Procedures" for submitting schedules and reports.
 - 2. Section 014000 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by Architect.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Event: The starting or ending point of an activity.
- E. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.

- 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

- F. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:

- 1. PDF electronic file.

- B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

- 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

- C. Daily Construction Reports: Submit at weekly intervals.

- D. Material Location Reports: Submit at weekly intervals.

- E. Field Condition Reports: Submit at time of discovery of differing conditions.

- F. Special Reports: Submit at time of unusual event.

1.5 QUALITY ASSURANCE

- A. Pre-scheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the Contractor's construction schedule, including, but not limited to, the following:

- 1. Review software limitations and content and format for reports.
- 2. Discuss constraints, including phasing, work stages and area separations.
- 3. Review time required for review of submittals and resubmittals.
- 4. Review requirements for tests and inspections by independent testing and inspecting agencies.
- 5. Review time required for completion and startup procedures.
- 6. Review and finalize list of construction activities to be included in schedule.
- 7. Review submittal requirements and procedures.
- 8. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

- B. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.

- 1. Secure time commitments for performing critical elements of the Work from entities involved.

2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 1. Activity Duration: Define activities so no activity is longer than twenty (20) days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than sixty (60) days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 4. Startup and Testing Time: Include not less than fifteen (15) days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 6. Punch List and Final Completion: Include not more than thirty (30) days for punch list and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.
 1. Phasing: Arrange list of activities on schedule by phase.
 2. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Uninterruptible services.
 - c. Use of premises restrictions.
 - d. Provisions for future construction.
 - e. Seasonal variations.
 - f. Environmental control.
 3. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Fabrication.
 - e. Sample testing.
 - f. Deliveries.

- g. Installation.
 - h. Tests and inspections.
 - i. Adjusting.
 - j. Startup and placement into final use and operation.
 - 4. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Completion of mechanical installation.
 - b. Completion of electrical installation.
 - c. Substantial Completion.
 - D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
 - E. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
 - 1. Refer to Section 012900 "Payment Procedures" for cost reporting and payment procedures.
 - F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 - 1. Unresolved issues.
 - 2. Unanswered RFIs.
 - 3. Rejected or unreturned submittals.
 - 4. Notations on returned submittals.
 - G. Recovery Schedule: When periodic update indicates the Work is fourteen (14) or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
 - H. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- 2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)
- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's construction schedule within seven (7) days of date established for the Notice to Proceed.
 - B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
 - 1. For construction activities that require three (3) months or longer to complete, indicate an estimated completion percentage in ten percent (10%) increments within time bar.

2.3 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (refer to special reports).
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. Material Location Reports: At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
- C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one (1) day of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one (1) week before each regularly scheduled progress meeting.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 - 3. As the Work progresses, indicate final completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Architect, Construction Administrator, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

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 administrative and procedural requirements for the following:
 - 1. Periodic construction photographs.
- B. Related Sections:
 - 1. Section 013300 "Submittal Procedures" for submitting photographic documentation.
 - 2. Section 017700 "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.

1.3 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels. Use flash in low light levels or backlit conditions.
- B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- C. Metadata: Record accurate date and time from camera.
- D. File Names: Name media files with date, Project area, and sequential numbering suffix.

1.4 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs using the maximum depth of field and in focus. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Field Office Images: Maintain one (1) set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.
- B. Periodic Construction Photographs: Take eighteen to twenty (18-20) photographs weekly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- C. Additional Photographs: Architect may request photographs in addition to periodic photographs specified.
 - 1. In emergency situations, take additional photographs within 24 hours of request.
 - 2. Circumstances that could require additional photographs include, but are not limited to, the following:

- a. Immediate follow-up when on-site events result in construction damage or losses.
- b. Substantial Completion of a major phase or component of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Sections:
 - 1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 3. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 4. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as action submittals.
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as informational submittals.
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or modifications to submittals noted by the Architect and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Submit concurrently with Contractor's construction schedule. Include submittals required during the first sixty (60) days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action, informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.
 - g. Scheduled dates for purchasing.
 - h. Scheduled dates for installation.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic copies of the Building Information Model (BIM) will **not** be provided by Architect for Vendor's use in preparing submittals unless requested and Architect's user agreement properly completed.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 1. Initial Review: Allow ten (10) days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Resubmittal Review: Allow ten (10) days for review of each resubmittal.
 3. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow fifteen (15) days for initial review of each submittal.
- D. Identification and Information: Place a permanent label or title block on each paper copy submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
 3. Include the following information for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 - f. Name of supplier.
 - g. Name of manufacturer.
 - h. Submittal number or other unique identifier, including revision identifier.
 - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Location(s) where product is to be installed, as appropriate.
 - l. Other necessary identification.
- E. Identification and Information: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 4. Include the following information on an inserted cover sheet:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.
 - f. Name of subcontractor.
 - g. Name of supplier.
 - h. Name of manufacturer.
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Location(s) where product is to be installed, as appropriate.
 - l. Related physical samples submitted directly.
 - m. Other necessary identification.
 5. Include the following information as keywords in the electronic file metadata:

- a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- F. Options: Identify options requiring selection by the Architect.
- G. Deviations: Identify deviations from the Contract Documents on submittals.
- H. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect observes non-compliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
- I. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review received from sources other than Contractor.
 - 1. Transmittal Form: Provide locations on form for the following information:
 - a. Project name.
 - b. Date.
 - c. Destination (To:).
 - d. Source (From:).
 - e. Names of subcontractor, manufacturer, and supplier.
 - f. Category and type of submittal.
 - g. Submittal purpose and description.
 - h. Specification Section number and title.
 - i. Indication of full or partial submittal.
 - j. Drawing number and detail references, as appropriate.
 - k. Transmittal number, numbered consecutively.
 - l. Submittal and transmittal distribution record.
 - m. Remarks.
 - n. Signature of transmitter.
 - 2. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- J. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- K. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- L. Use for Construction: Use only final submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Submit electronic submittals via email as PDF electronic files.
 - a. Architect will return annotated file. Annotate and retain one (1) copy of file as an electronic Project record document file.
 2. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
 3. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
 4. Test and Inspection Reports Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before or concurrent with Samples.

- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8½ by 11 inches but no larger than 30 by 42 inches.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one (1) submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine the final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
- F. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- G. Application for Payment: Comply with requirements specified in Section 012900 "Payment Procedures."

- H. Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."
- I. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- J. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Architects and Owners, and other information specified.
- K. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.
- L. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- M. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- N. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- O. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- P. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- Q. Product Test Reports: Submit written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- R. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.

- S. Schedule of Tests and Inspections: Comply with requirements specified in Section 014000 "Quality Requirements."
- T. Pre-construction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- U. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- V. Field Test Reports: Submit reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- W. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Section 017700 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. **General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.**
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- E. Incomplete submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

- F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections:
 - 1. Divisions 02 through 49 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract enforcement activities performed by Architect.
- C. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

- D. Pre-construction Testing: Tests and inspections performed specifically for the Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- G. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade or trades.
- J. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five (5) previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.5 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two (2) or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

- A. Shop Drawings: For mockups.
 - 1. Include plans, sections, and elevations, indicating materials and size of mockup construction.
 - 2. Indicate manufacturer and model number of individual components.
 - 3. Provide axonometric drawings for conditions difficult to illustrate in two (2) dimensions.
- B. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems.
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within ten (10) days of Notice to Proceed, and not less than five (5) days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: Include in quality-control plan a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
 - 3. Owner-performed tests and inspections indicated in the Contract Documents.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as non-conforming or defective. Indicate corrective actions taken to bring non-conforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.

11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 - 2. Notify Architect seven (7) days in advance of dates and times when mockups will be constructed.
 - 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at the Project.
 - 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven (7) days for initial review and each re-review of each mockup.
 - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed, unless otherwise indicated.

1.11 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
 - 3. Costs for testing that is cancelled will be charged to the Contractor, and the Contract Sum will be adjusted by Change Order.

- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.
- 1.12 SPECIAL TESTS AND INSPECTIONS
- A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect, Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.

- B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.
 - 1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

Statement of Special Inspections

Project: *Interior Alterations at Amity Regional High School Media Center*

Location: *25 Newton Road, Woodbridge, CT 06525*

Owner: *Regional School District #5*

Structural Engineer of Record: *Michael Horton Associates, Inc.*

This *Statement of Special Inspections* is submitted as a condition for permit issuance in accordance with the Special Inspection and Structural Testing requirements of the Building Code. It includes a schedule of Special Inspection services applicable to this project as well as the name of the Special Inspection Coordinator and the identity of other approved agencies to be retained for conducting these inspections and tests. This *Statement of Special Inspections* encompass the following disciplines:

☒ Structural ☐ Mechanical/Electrical/Plumbing
☐ Architectural ☐ Other: _____

The Special Inspection Coordinator shall keep records of all inspections and shall furnish inspection reports to the Building Official and the Structural Engineer of Record. Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official and the Structural Engineer of Record. The Special Inspection program does not relieve the Contractor of his or her responsibilities.

Interim reports shall be submitted to the Building Official and the Structural Engineer of Record.

A *Final Report of Special Inspections* documenting completion of all required Special Inspections, testing and correction of any discrepancies noted in the inspections shall be submitted prior to issuance of a Certificate of Use and Occupancy.

Job site safety and means and methods of construction are solely the responsibility of the Contractor.

Interim Report Frequency: *Monthly* or ☐ per attached schedule.

Prepared by:

Paul J. Sheehan, P.E.

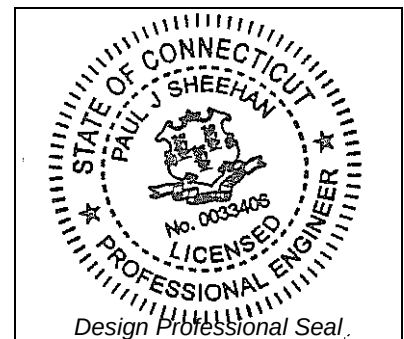
(type or print name)



Signature

11-07-2025

Date



Owner's Authorization:

Building Official's Acceptance:

Signature

Date

Signature

Date

Schedule of Inspection and Testing Agencies

This Statement of Special Inspections / Quality Assurance Plan includes the following building systems:

☐ Soils and Foundations	☐ Spray Fire Resistant Material
☐ Cast-in-Place Concrete	☐ Wood Construction
☐ Precast Concrete	☐ Exterior Insulation and Finish System
☐ Masonry	☐ Mechanical & Electrical Systems
☒ Structural Steel	☐ Architectural Systems
☐ Cold-Formed Steel Framing	☐ Special Cases

Special Inspection Agencies	Firm	Address, Telephone, e-mail
1. Special Inspection Coordinator	TBD	
2. Inspector		
3. Inspector		
4. Testing Agency	TBD	
5. Testing Agency		
6. Other		

Note: The inspectors and testing agencies shall be engaged by the Owner or the Owner's Agent, and not by the Contractor or Subcontractor whose work is to be inspected or tested. Any conflict of interest must be disclosed to the Building Official, prior to commencing work.

Quality Assurance Plan

Quality Assurance for Seismic Resistance

Seismic Design Category	<i>B</i>
Quality Assurance Plan Required (Y/N)	<i>N</i>

Description of seismic force resisting system and designated seismic systems:

Quality Assurance for Wind Requirements

Basic Wind Speed (3 second gust)	<i>120mph</i>
Wind Exposure Category	<i>B</i>
Quality Assurance Plan Required (Y/N)	<i>N</i>

Description of wind force resisting system and designated wind resisting components:

Statement of Responsibility

Each contractor responsible for the construction or fabrication of a system or component designated above must submit a Statement of Responsibility.

Qualifications of Inspectors and Testing Technicians

The qualifications of all personnel performing Special Inspection and testing activities are subject to the approval of the Building Official. The credentials of all Inspectors and testing technicians shall be provided if requested.

Key for Minimum Qualifications of Inspection Agents:

When the Registered Design Professional in Responsible Charge deems it appropriate that the individual performing a stipulated test or inspection have a specific certification or license as indicated below, such designation shall appear below the *Agency Number* on the Schedule.

PE/SE	Structural Engineer – a licensed SE or PE specializing in the design of building structures
PE/GE	Geotechnical Engineer – a licensed PE specializing in soil mechanics and foundations
EIT	Engineer-In-Training – a graduate engineer who has passed the Fundamentals of Engineering examination

American Concrete Institute (ACI) Certification

ACI-CFTT	Concrete Field Testing Technician – Grade 1
ACI-CCI	Concrete Construction Inspector
ACI-LTT	Laboratory Testing Technician – Grade 1&2
ACI-STT	Strength Testing Technician

American Welding Society (AWS) Certification

AWS-CWI	Certified Welding Inspector
AWS/AISC-SSI	Certified Structural Steel Inspector

American Society of Non-Destructive Testing (ASNT) Certification

ASNT	Non-Destructive Testing Technician – Level II or III.

International Code Council (ICC) Certification

ICC-SMSI	Structural Masonry Special Inspector
ICC-SWSI	Structural Steel and Welding Special Inspector
ICC-SFSI	Spray-Applied Fireproofing Special Inspector
ICC-PCSI	Prestressed Concrete Special Inspector
ICC-RCSI	Reinforced Concrete Special Inspector

National Institute for Certification in Engineering Technologies (NICET)

NICET-CT	Concrete Technician – Levels I, II, III & IV
NICET-ST	Soils Technician - Levels I, II, III & IV
NICET-GET	Geotechnical Engineering Technician - Levels I, II, III & IV

Exterior Design Institute (EDI) Certification

EDI-EIFS	EIFS Third Party Inspector

Other

Item	Agency # (Qualif.)	Scope
1. Fabricator Certification/ Quality Control Procedures ☒ Fabricator Exempt		<i>Review shop fabrication and quality control procedures.</i>
2. Material Certification		<i>Review certified mill test reports and identification markings on wide-flange shapes, high-strength bolts, nuts and welding electrodes</i>
3. Open Web Steel Joists		<i>Not Applicable</i>
4. Bolting		<i>Inspect installation and tightening of high-strength bolts. Verify that splines have separated from tension control bolts. Verify proper tightening sequence. Continuous inspection of bolts in slip-critical connections.</i>
5. Welding		<i>Visually inspect all welds. Inspect pre-heat, post-heat and surface preparation between passes. Verify size and length of fillet welds.</i> <i>Ultrasonic testing of all full-penetration welds.</i>
6. Shear Connectors		<i>Not Applicable</i>
7. Structural Details		<i>Inspect steel frame for compliance with structural drawings, including bracing, member configuration and connection details.</i>
8. Metal Deck		<i>Not Applicable</i>
9. Other:		

SECTION 014200 - REFERENCES

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 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless 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.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
 - 1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
11. AF&PA - American Forest & Paper Association; www.afandpa.org.
12. AGA - American Gas Association; www.aga.org.
13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
15. AI - Asphalt Institute; www.asphaltinstitute.org.
16. AIA - American Institute of Architects (The); www.aia.org.
17. AISC - American Institute of Steel Construction; www.aisc.org.
18. AISI - American Iron and Steel Institute; www.steel.org.
19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
21. ANSI - American National Standards Institute; www.ansi.org.
22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
23. APA - APA - The Engineered Wood Association; www.apawood.org.
24. APA - Architectural Precast Association; www.archprecast.org.
25. API - American Petroleum Institute; www.api.org.
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
34. ASSP - American Society of Safety Professionals (The); www.assp.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AVIXA - Audiovisual and Integrated Experience Association; (Formerly: Infocomm International); www.soundandcommunications.com.

38. AWEA - American Wind Energy Association; www.awea.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
48. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
49. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
50. CDA - Copper Development Association; www.copper.org.
51. CE - Conformite Europeenne; www.ec.europa.eu/growth/single-market/ce-marking.
52. CEA - Canadian Electricity Association; www.electricity.ca.
53. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.compositepanel.org.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
64. CSA - CSA Group; www.csa-group.org.
65. CSI - Construction Specifications Institute (The); www.csiresources.org.
66. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
67. CTA - Consumer Technology Association; www.cta.tech.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.coolingtechnology.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHA - Decorative Hardwoods Association; (Formerly: Hardwood Plywood & Veneer Association); www.decorativehardwoods.org.
72. DHI - Door and Hardware Institute; www.dhi.org.
73. ECA - Electronic Components Association; (See ECIA).
74. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
75. ECIA - Electronic Components Industry Association; www.ecianow.org.
76. EIA - Electronic Industries Alliance; (See TIA).
77. EIMA - EIFS Industry Members Association; www.eima.com.
78. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
79. EOS/ESD Association; (Electrostatic Discharge Association); www.esda.org.
80. ESTA - Entertainment Services and Technology Association; (See PLASA).
81. ETL - Intertek (See Intertek); www.intertek.com.
82. EVO - Efficiency Valuation Organization; www.evo-world.org.
83. FCI - Fluid Controls Institute; www.fluidcontrolsintstitute.org.
84. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
85. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
86. FM Approvals - FM Approvals LLC; www.fmglobal.com.

87. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmgglobal.com.
88. FRSA - Florida Roofing, Sheet Metal Contractors Association, Inc.; www.floridarooft.com.
89. FSA - Fluid Sealing Association; www.fluidsealing.com.
90. FSC - Forest Stewardship Council U.S.; www.fscus.org.
91. GA - Gypsum Association; www.gypsum.org.
92. GANA - Glass Association of North America; (See NGA).
93. GS - Green Seal; www.greenseal.org.
94. HI - Hydraulic Institute; www.pumps.org.
95. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
96. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
97. HPVA - Hardwood Plywood & Veneer Association; (See DHA).
98. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
99. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
100. IAS - International Accreditation Service; www.iasonline.org.
101. ICBO - International Conference of Building Officials; (See ICC).
102. ICC - International Code Council; www.iccsafe.org.
103. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
104. ICPA - International Cast Polymer Association; www.theicpa.com.
105. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
106. IEC - International Electrotechnical Commission; www.iec.ch.
107. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
108. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
109. IESNA - Illuminating Engineering Society of North America; (See IES).
110. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
111. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
112. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
113. II - Infocomm International; (See AVIXA).
114. ILI - Indiana Limestone Institute of America, Inc.; www.ili.ai.com.
115. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
116. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
117. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
118. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
119. ISO - International Organization for Standardization; www.iso.org.
120. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
121. ITU - International Telecommunication Union; www.itu.int.
122. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
123. LMA - Laminating Materials Association; (See CPA).
124. LPI - Lightning Protection Institute; www.lightning.org.
125. MBMA - Metal Building Manufacturers Association; www.mbma.com.
126. MCA - Metal Construction Association; www.metalconstruction.org.
127. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
128. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
129. MHI - Material Handling Industry of America; www.mhia.org.
130. MIA - Marble Institute of America; (See NSI).
131. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
132. MPI - Master Painters Institute; www.paintinfo.com.
133. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
134. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
135. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
136. NADCA - National Air Duct Cleaners Association; www.nadca.com.

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137. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
 138. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
 139. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
 140. NBI - New Buildings Institute; www.newbuildings.org.
 141. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
 142. NCMA - National Concrete Masonry Association; www.ncma.org.
 143. NEBB - National Environmental Balancing Bureau; www.nebb.org.
 144. NECA - National Electrical Contractors Association; www.necanet.org.
 145. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
 146. NEMA - National Electrical Manufacturers Association; www.nema.org.
 147. NETA - InterNational Electrical Testing Association; www.netaworld.org.
 148. NFHS - National Federation of State High School Associations; www.nfhs.org.
 149. NFPA - National Fire Protection Association; www.nfpa.org.
 150. NFPA - NFPA International; (See NFPA).
 151. NFRC - National Fenestration Rating Council; www.nfrc.org.
 152. NGA - National Glass Association (The); (Formerly: Glass Association of North America); www.glass.org.
 153. NHLA - National Hardwood Lumber Association; www.nhla.com.
 154. NLGA - National Lumber Grades Authority; www.nlga.org.
 155. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
 156. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
 157. NRCA - National Roofing Contractors Association; www.nrca.net.
 158. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
 159. NSF - NSF International; www.nsf.org.
 160. NSI - National Stone Institute; (Formerly: Marble Institute of America); www.naturalstoneinstitute.org.
 161. NSPE - National Society of Professional Engineers; www.nspe.org.
 162. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
 163. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
 164. NWFA - National Wood Flooring Association; www.nwfa.org.
 165. NWRA - National Waste & Recycling Association; www.wasterecycling.org.
 166. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
 167. PDI - Plumbing & Drainage Institute; www.pdionline.org.
 168. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
 169. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
 170. RFCI - Resilient Floor Covering Institute; www.rfci.com.
 171. RIS - Redwood Inspection Service; www.redwoodinspection.com.
 172. SAE - SAE International; www.sae.org.
 173. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
 174. SDI - Steel Deck Institute; www.sdi.org.
 175. SDI - Steel Door Institute; www.steeldoor.org.
 176. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
 177. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
 178. SIA - Security Industry Association; www.siaonline.org.
 179. SJI - Steel Joist Institute; www.steeljoist.org.
 180. SMA - Screen Manufacturers Association; www.smainfo.org.
 181. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
 182. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
 183. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
 184. SPIB - Southern Pine Inspection Bureau; www.spib.org.
 185. SPRI - Single Ply Roofing Industry; www.spri.org.
 186. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.

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187. SSINA - Specialty Steel Industry of North America; www.ssina.com.
 188. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
 189. STI - Steel Tank Institute; www.steeltank.com.
 190. SWI - Steel Window Institute; www.steelwindows.com.
 191. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
 192. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
 193. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
 194. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
 195. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
 196. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
 197. TMS - The Masonry Society; www.masonrysociety.org.
 198. TPI - Truss Plate Institute; www.tpinst.org.
 199. TPI - Turfgrass Producers International; www.turfgrasssod.org.
 200. TRI - Tile Roofing Institute; www.tilerroofing.org.
 201. UL - Underwriters Laboratories Inc.; www.ul.com.
 202. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
 203. USAV - USA Volleyball; www.usavolleyball.org.
 204. USGBC - U.S. Green Building Council; www.usgbc.org.
 205. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
 206. WA - Wallcoverings Association; www.wallcoverings.org.
 207. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
 208. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
 209. WDMA - Window & Door Manufacturers Association; www.wdma.com.
 210. WI - Woodwork Institute; www.wicnet.org.
 211. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
 212. WWPA - Western Wood Products Association; <http://www.wwpa.org>.
- B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.
1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
 2. ICC - International Code Council; www.iccsafe.org.
 3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.
- C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.
1. COE - Army Corps of Engineers; www.usace.army.mil.
 2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
 3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
 4. DOD - Department of Defense; www.quicksearch.dla.mil.
 5. DOE - Department of Energy; www.energy.gov.
 6. EPA - Environmental Protection Agency; www.epa.gov.
 7. FAA - Federal Aviation Administration; www.faa.gov.
 8. FG - Federal Government Publications; www.gpo.gov/fdsys.
 9. GSA - General Services Administration; www.gsa.gov.
 10. HUD - Department of Housing and Urban Development; www.hud.gov.
 11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.

12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
 13. SD - Department of State; www.state.gov.
 14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
 15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
 16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
 17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
 18. USP - U.S. Pharmacopeial Convention; www.usp.org.
 19. USPS - United States Postal Service; www.usps.com.
- D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.govinfo.gov.
 2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.
 3. DSCC - Defense Supply Center Columbus; (See FS).
 4. FED-STD - Federal Standard; (See FS).
 5. FS - Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.
 6. MILSPEC - Military Specification and Standards; (See DOD).
 7. USAB - United States Access Board; www.access-board.gov.
 8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

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 requirements for temporary support, security, and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary of Work" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

- A. Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

- A. Field Offices: Pre-fabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading, if required. Unit must be large enough for regular job meetings, plan review areas, submittal storage, and other job file and administrative functions.
 - 1. If provided, Contractor will be responsible for its complete installation, including anchoring if required by authority having jurisdiction.
 - 2. No building space will be provided by the Owner for the Contractor's field office.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Sheds to be metal box storage units or have wood floors raised above the ground.
 - 2. Store combustible materials apart from building.

2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- D. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- E. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- F. Electronic Communication Service: Regardless of availability of Owner's service, the Contractor shall maintain at his expense secure and reliable WiFi wireless connection to internet with provisions for access by Architect, the Owner's staff, Municipal Officials or Inspectors, and all subcontractors.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
1. Provide construction for temporary sheds located within construction area or within 30 feet of building lines that is non-combustible according to ASTM E 136. Comply with NFPA 241.
 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- C. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- D. Storage and Staging: Use designated areas of Project site for storage and staging needs.
- E. Project Signs: Provide Project signs as required by Owner. Unauthorized signs are not permitted.
1. Identification Signs: Provide Project identification signs.
 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 3. Maintain and touch up signs so they are legible at all times.
- F. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."
- G. Existing Elevator Use: Use of elevators for construction activities is not permitted.
- H. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- D. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- B. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 - 2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Sections:
 - 1. Section 012500 "Substitution Procedures" for requests for substitutions.
 - 2. Section 014200 "References" for applicable industry standards for products specified.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.

2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one (1) week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.

- a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
- b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two (2) or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

- B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

- C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
5. Protect stored products from damage and liquids from freezing.
6. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. Refer to Divisions 02 through 49. Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or non-standard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures:
1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 3. Products:

- a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one (1) of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered, unless otherwise indicated.
 - b. Non-Restricted List: Where Specifications include a list of names of both available manufacturers and products, provide one (1) of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
 - 4. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one (1) of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered, unless otherwise indicated.
 - b. Non-Restricted List: Where Specifications include a list of available manufacturers, provide a product by one (1) of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
 - 5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one (1) of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one (1) of the other named manufacturers.
 - C. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.
- ## 2.2 COMPARABLE PRODUCTS
- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
 - 1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 - 2. Detailed, SIDE-BY-SIDE comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - 3. Evidence that proposed product provides specified warranty.
 - 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 - 5. Samples, if requested.
 - 6. Comply with requirements of Section 012500 "Substitution Procedures".

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

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 general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Installation of the Work.
 - 2. Cutting and patching.
 - 3. Progress cleaning.
 - 4. Starting and adjusting.
 - 5. Protection of installed construction.
 - 6. Correction of the Work.
- B. Related Sections:
 - 1. Section 017700 "Closeout Procedures" for submitting recording of Owner-accepted deviations from indicated lines and levels and final cleaning.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from the Architect before proceeding. Shore, brace, and support structural element during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
 - 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
 - 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
 - 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner

that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

1.5 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to the Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of utilities and construction indicated as existing are not guaranteed.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - a. Description of the Work.
 - b. List of detrimental conditions, including substrates.
 - c. List of unacceptable installation tolerances.
 - d. Recommended corrections.
 - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.

5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of the Contractor, submit a request for information to Architect according to requirements in Section 013100 "Project Management and Coordination."

3.3 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 2. Allow for building movement, including thermal expansion and contraction.

- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.4 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Temporary Support: Provide temporary support of work to be cut.
- C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- D. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching.
- E. Existing Utility Services: Where existing services are required to be removed, relocated, or abandoned, bypass such systems before cutting to minimize interruption to occupied areas.
- F. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 5. Proceed with patching after construction operations requiring cutting are complete.
- G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

- a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
- H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.5 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. **Empty or remove dumpsters at the end of each work week.** Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven (7) days during normal weather or three (3) days if the temperature is expected to rise above 80 deg F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Utilize containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where more than one (1) installer has worked.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.6 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.7 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.8 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
- B. Related Sections:
 - 1. Section 017300 "Execution" for progress cleaning of Project site.
 - 2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 3. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 4. Section 017900 "Demonstration and Training" for requirements for instructing Owner's personnel.
 - 5. Divisions 02 through 49 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete with request.
 - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 - 2. Advise Owner of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, and similar final record information.
 - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - 7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 8. Complete startup testing of systems.
 - 9. Submit test/adjust/balance records.

10. Terminate and remove temporary facilities from Project site, along with construction tools and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 012900 "Payment Procedures".
2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
5. Secure and provide both temporary and final Certificate of Occupancy from the Building Official, meeting all local and state permit closeout requirements.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

C. CT DOE OGA Closeout Assistance:

1. The Contractor shall assist the Architect and Owner with the Office of Grants Administration closeout and any audit of the project by providing supplemental cost or scope information related to their work or change orders that were executed during the course of the project. This assistance may require administrative support from the Contractor's office but may also require in-person attendance at meetings with the Owner, and any information requested by the Owner must be provided within five (5) calendar days of the request.

2. This closeout service shall be provided at no additional expense to the project, and may be required as much as twenty-four (24) months after the final date of substantial completion of the project.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use **CSI Form 14.1A** or comparable form.
 1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Page number.
 4. Submit list of incomplete items in the following format:
 - a. PDF electronic file. Architect will return annotated file.

1.6 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Partial Occupancy: Submit properly executed warranties within fifteen (15) days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8½-by-11-inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
 4. Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide table of contents at beginning of document.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION (Not Used)

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

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 administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Sections:
 - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.
 - 3. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual specification sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. Two (2) thumb drives. Enable review comments on draft submittals.
 - 2. Two (2) paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Architect will return both copies to be given to the Owner.

- C. Initial Manual Submittal: Submit draft copy of each manual at least thirty (30) days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least fifteen (15) days before commencing demonstration and training. Architect will return copy with comments.
 - 1. Correct or modify each manual to comply with Architect's comments. Submit copies of each corrected manual within fifteen (15) days of receipt of Architect's comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
 - 1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8½-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two (2) or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 - 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 - 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
 - 4. Supplementary Text: Prepared on 8½-by-11-inch white bond paper.

5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 1. Title page.
 2. Table of contents.
 3. Manual contents.
- B. Title Page: Include the following information:
 1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Architect.
 7. Name and contact information for Commissioning Authority.
 8. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 9. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 1. If operation or maintenance documentation requires more than one (1) volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one (1) system into a single binder.

1.7 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
 1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.

- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 - 1. Fire.
 - 2. Flood.
 - 3. Gas leak.
 - 4. Water leak.
 - 5. Power failure.
 - 6. Water outage.
 - 7. System, subsystem, or equipment failure.
 - 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
 - 1. Instructions on stopping.
 - 2. Shutdown instructions for each type of emergency.
 - 3. Operating instructions for conditions outside normal operating limits.
 - 4. Required sequences for electric or electronic systems.
 - 5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Performance and design criteria if Contractor is delegated design responsibility.
 - 3. Operating standards.
 - 4. Operating procedures.
 - 5. Operating logs.
 - 6. Wiring diagrams.
 - 7. Control diagrams.
 - 8. Piped system diagrams.
 - 9. Precautions against improper use.
 - 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated on Contract Documents.

2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one (1) item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

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 administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Sections:
 - 1. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 3. Divisions 02 through 49 Sections for specific requirements for project record documents of the Work in those Sections.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one (1) set(s) of marked-up record prints.
- B. Record Specifications: Submit one (1) paper copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one (1) paper copy of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one (1) set of marked-up paper copies of the Contract Drawings and Shop Drawings.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

- a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding archive photographic documentation.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Revisions to routing of piping and conduits.
 - d. Revisions to electrical circuitry.
 - e. Actual equipment locations.
 - f. Duct size and routing.
 - g. Locations of concealed internal utilities.
 - h. Changes made by Change Order or Construction Change Directive.
 - i. Changes made following Architect's written orders.
 - j. Details not on the original Contract Drawings.
 - k. Field records for variable and concealed conditions.
 - l. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Paper copy.
 3. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as paper copy.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as paper copy.

1. Include record Product Data directory organized by specification section number and title, electronically linked to each item of record Product Data.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one (1) copy of each submittal during the construction period for project record document purposes. Post changes and modifications to project record documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

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 administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
- B. Related Sections:
 - 1. Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections.

1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules utilizing manufacturer-produced demonstration for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Attendance Record: For each training module, submit list of participants and length of instruction time.
- C. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Pre-Instruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor has delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 3. Emergencies: Include the following, as applicable:

- a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
- a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
- a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operations and Maintenance Data."
- B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Architect will furnish an instructor to describe basis-of-system-design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner with at least seven (7) days advance notice.
- D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test and ask Owner to sign-off on for acceptance.
- E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 017900

SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. OPR and BOD documentation are to be provided by EOR and should be included as 100% documentation when completed and provided for reference.

1.2 SUMMARY

- A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.
- B. Commissioning is a systematic process to provide documented confirmation that building systems perform according to the criteria set forth in the design intent and satisfy the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training.
- C. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - 2. Verify that applicable equipment and systems have adequate access for maintenance.
 - 3. Verify and document proper performance of equipment and systems.
 - 4. Verify that O&M documentation left on site is complete.
 - 5. Verify that the Owner's operating personnel are adequately trained.
- D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.
- E. Abbreviations. The following are common abbreviations used in the *Specifications* and in the *Commissioning Plan*. Definitions are found in Section 1.3.

A/E - Architect and design engineers	GC - General contractor
CC - Controls contractor	MC - Mechanical contractor
CM - Construction Manager	OR - Owner's Representative
Cx - Commissioning	PFT - Prefunctional Tests and checklist
Cx Plan - Commissioning Plan document	PM - Project manager (of the Owner)
EC - Electrical contractor	Subs - Subcontractors to General
FPT - Functional performance test	TAB - Test and balance contractor

- F. Related Sections:
1. Division 013100x Section "Project Management and Coordination" to introduce commissioning and refers to this section.
 2. Division 013300 Section "Submittal Procedures" for additional detail in submittals required for commissioning.
 3. Division 017700 Section "Closeout Procedures" which defines substantial completion and functional completion, relative to commissioning.
 4. Division 0177823 Section "Operation and Maintenance Data" defines commissioning documentation requirements.
 5. Division 230800 Section "Commissioning of HVAC Systems" for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.
 6. Division 260800 Section "Commissioning of Electrical Systems" for commissioning process activities for integrated automation systems, assemblies, equipment, and components.

1.3 DEFINITIONS

- A. Acceptance Phase. Phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occurs.
- B. Approval. Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.
- C. Architect/Engineer (A/E): The prime consultant (architect) and sub-consultants who comprise the design team, generally the HVAC mechanical designer/engineer and the electrical designer/engineer.
- D. BOD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- E. Construction Manager (CM): The prime contractor for this project. Generally, refers to all the CM's subcontractors as well. Also referred to as the Contractor, in some contexts. The CM is hired by the owner and is authorized to oversee the fulfillment of all requirements of the Contract Documents.
- F. Cx: Commissioning Authority. An independent agent, not otherwise associated with the A/E team members or the Contractor, hired by the Owner. The Cx directs and coordinates the day-to-day commissioning activities. The Cx does not take an oversight role. The Cx is part of the Construction Team and shall report directly to the Owner or Owners Representative.
- G. Cx Plan: Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process
- H. Datalogging: Monitoring flows, currents, status, pressures, etc. of equipment using stand-alone dataloggers separate from the control system.
- I. Deferred Functional Performance Tests: FPTs that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.

- J. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the design intent)
- K. Design Intent: A dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases.
- L. Design Narrative or Design Documentation: Sections of either the Design Intent or Basis of Design.
- M. Factory Testing: Testing of equipment on-site or at the factory by factory personnel with an Owner's representative present.
- N. Functional Performance Test (FPT): Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows, and pressures as specified, while functional testing is verifying that which has already been set up. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. FPTs are performed after prefunctional checklists and startup are complete.
- O. Construction Manager (CM): The prime contractor for this project. Generally, refers to all the CM's subcontractors as well. Also referred to as the Contractor, in some contexts. [
- P. Indirect Indicators: Indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed
- Q. Manual Test: Using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- R. Monitoring: The recording of parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of control systems.
- S. Non-Compliance: See Deficiency.
- T. Non-Conformance: See Deficiency.
- U. Over-rides: Writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50F to 75F to verify economizer operation). See also "Simulated Signal."
- V. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

- W. Prefunctional Tests and Checklist (PFT): A list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the Subcontractors to the Cx. Prefunctional checklists are primarily static inspections performed by the installing contractors as well as the factory start up. The commissioning authority only requires that the procedures be documented in writing and does not witness much of the prefunctional check listing, except for larger or more critical pieces of equipment.
- X. Sampling: Functionally testing only a fraction of the total number of identical or near identical pieces of equipment.
- Y. Seasonal Functional Performance Tests: FPT's that are deferred until the system(s) will experience conditions closer to their design conditions.
- Z. Simulated Condition: Condition that is created for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).
- AA. Simulated Signal: Disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.
- BB. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- CC. Startup: The initial starting or activating of dynamic equipment, including executing prefunctional checklists.
- DD. Subs: The subcontractors to the CM who provide and install building components and systems.
- EE. Test Procedures: The step-by-step process which must be executed to fulfill the test requirements. The test procedures are developed by the Cx.
- FF. Test Requirements: Requirements specifying what modes and functions, etc. shall be tested. The test requirements are not the detailed test procedures. The test requirements are specified in the Contract Documents
- GG. Trending: Monitoring using the building control system.
- HH. Vendor: Supplier of equipment.
- II. Warranty Period: Warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

1.4 COORDINATION

- A. Commissioning Team. The members of the commissioning team consist of the Commissioning authority (Cx), the Owner's Representative (OR), the designated representative of the owner's, the Construction Manager (CM), the Architect and design Engineers (AE, particularly the mechanical engineer), the Mechanical Contractor (MC), the Electrical Contractor (EC), the TAB representative, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment. If known, the Owner's building or plant operator/engineer is also a member of the commissioning team.

- B. Management. The Cx is hired by the Owner directly. The Cx directs and coordinates the commissioning activities and the reports to the OR. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
- C. Scheduling. The Cx will work with the CM according to established protocols to schedule the commissioning activities. The CM will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- D. The Cx will provide the initial schedule of primary commissioning events at the commissioning scoping meeting. The *Commissioning Plan—Construction Phase* provides a format for this schedule. As construction progresses more detailed schedules are developed by the Cx. The Commissioning Plan also provides a format for detailed schedules.

1.5 COMMISSIONING PROCESS

- A. Commissioning Plan. The Commissioning Plan is binding on the Contractor. The commissioning plan provides guidance in the execution of the commissioning process. Just after the initial commissioning scoping meeting the Cx will update the plan which is then considered the “final” plan, though it will continue to evolve and expand as the project progresses. The *Specifications* will take precedence over the Commissioning Plan.
- B. Commissioning Process. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
 - 1. Commissioning during construction begins with a scoping meeting conducted by the Cx where the commissioning process is reviewed with the commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the Cx with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
 - 3. Equipment documentation is submitted to the Cx during normal submittals, including detailed start-up procedures.
 - 4. The Cx works with the Subs in developing startup plans and startup documentation formats, including providing the Subs with prefunctional checklists to be completed, during the startup process.
 - 5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional testing.
 - 6. The Subs, under their own direction, execute and document the prefunctional checklists and perform startup and initial checkout. The Cx documents that the checklists and startup were completed according to the approved plans. This may include the Cx witnessing start-up of selected equipment.
 - 7. The Cx develops specific equipment and system functional performance test procedures. The Subs review the procedures.
 - 8. The procedures are executed by the Subs, under the direction of, and documented by the Cx.
 - 9. Items of non-compliance in material, installation or setup are corrected at the Sub's expense and the system retested.
 - 10. The Cx reviews the O&M documentation for completeness.
 - 11. Commissioning is completed before Substantial Completion.
 - 12. The Cx reviews, pre-approves and coordinates the training provided by the Subs and verifies that it was completed.
 - 13. Seasonal, Phased, and/or Deferred testing is conducted, as specified or required.

1.6 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, the Construction Manager CM and representatives of the Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the Cx.
- B. Members Appointed by Owner:
 - 1. Cx: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the Cx under a separate contract.
 - 2. Representatives of the facility user and operation and maintenance personnel.
 - 3. The Owners Representative.
 - 4. Architect and Engineering design professionals.

1.7 OWNER'S RESPONSIBILITIES

- A. The Owner may participate in the commissioning process including, but not limited to, the following:
 - 1. Provide the OPR documentation to the Cx and Contractor for information and use.
 - 2. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
 - 3. Provide the BOD documentation, prepared by Architect and approved by Owner, to the Cx and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.
 - 4. Follow the Commissioning Plan.
 - 5. Attend commissioning scoping meetings and additional meetings as necessary.

1.8 ARCHITECT/ENGINEERS (AE) RESPONSIBILITIES

- A. The AE shall participate in and perform commissioning process activities including, but not limited to, the following:
 - 1. Attend the commissioning scoping meeting and selected commissioning team meetings.
 - 2. Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted.
 - 3. Provide any design narrative and sequence documentation requested by the Cx. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - 4. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
 - 5. Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
 - 6. Coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning.
 - 7. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.

1.9 CONSTRUCTION MANAGER'S (CM) RESPONSIBILITIES

- A. The Construction Manager may participate in and perform commissioning process activities including, but not limited to the following:
1. Facilitate the coordination of the commissioning work by the Cx and ensure that commissioning activities are being scheduled into the master schedule.
 2. Review and approve the final Commissioning Plan—Construction Phase.
 3. Attend a commissioning scoping meeting and other commissioning team meetings.
 4. Perform the normal review of Contractor submittals.
 5. Furnish a copy of all construction documents, addenda, requests for information, change orders and approved submittals and shop drawings related to commissioned equipment to the Cx.
 6. Review and approve the functional performance test procedures submitted by the Cx, prior to testing.
 7. Review commissioning progress and deficiency reports.
 8. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
 9. Follow the Commissioning Plan.
 10. Attend commissioning scoping meetings and additional meetings as necessary.

1.10 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 2. Cooperate with the Cx for resolution of issues recorded in the Issues Log.
 3. Attend commissioning team meetings held on a monthly basis.
 4. Integrate and coordinate commissioning process activities with construction schedule.
 5. Review commissioning progress and deficiency reports.
 6. Review and accept construction checklists provided by the Cx.
 7. Complete paper or electronic construction checklists as work is completed and provide to the Cx on a weekly basis.
 8. Review and accept commissioning process test procedures provided by the Commissioning Authority.
 9. Complete commissioning process test procedures.
 10. Include the cost of commissioning in the total contract price.
 11. Coordinate the training of Owner personnel and provide the times and dates of training to the Cx.
 12. Execute seasonal or deferred functional performance testing witnessed by the Cx to facilitate the Cx process.
 13. Provide a list of final settings, setpoints, ranges, schedules, and / or trend logs required by the Cx.
 14. Follow the Commissioning Plan.
 15. Attend commissioning scoping meetings and additional meetings as necessary.
 16. From the red-line drawings, edit and update one-line diagrams developed as part of the design narrative documentation and those provided by the vendor as shop drawings for the chilled and hot water, condenser water, domestic water, steam and condensate systems; supply, return and exhaust air systems and emergency power system.

1.11 SUB CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
 2. Assist in equipment testing per agreements with Prime.
 3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the Cx.
 4. Provide information requested by Cx regarding equipment sequence of operation and testing procedures.
 5. Review test procedures for equipment installed by factory representatives.
 6. Follow the Commissioning Plan.
 7. Attend commissioning scoping meetings and additional meetings as necessary.

1.12 EQUIPMENT SUPPLIERS RESPONSIBILITIES

- A. The equipment suppliers shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
 2. Assist in equipment testing per agreements with Subs.
 3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone datalogging equipment that may be used by the Cx.
 4. Through the contractors they supply products to, analyze specified products and verify that the designer has specified the newest most updated equipment reasonable for this project's scope and budget.
 5. Provide information requested by Cx regarding equipment sequence of operation and testing procedures.
 6. Review test procedures for equipment installed by factory representatives.
 7. Follow the Commissioning Plan.
 8. Attend commissioning scoping meetings and additional meetings as necessary.

1.13 Cx'S RESPONSIBILITIES

- A. The Cx is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The Cx may assist with problem-solving, non-conformance or deficiencies, but ultimately that responsibility resides with the CM and the A/E. The primary role of the Cx is to develop and coordinate the execution of a testing plan, observe and document performance and ensure that systems are functioning in accordance with the documented design intent and the Contract Documents. The Contractors will provide all tools or the use of tools to start, check-out and functionally test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the Cx.

1. Coordinates and directs the commissioning activities using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
2. Coordinate the commissioning work and, with the CM, ensure that commissioning activities are being scheduled into the master schedule.
3. Revise, as necessary, the Commissioning Plan—Construction Phase.
4. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
5. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.
6. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
7. Review and comment on normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
8. Assist with review and approvals of contractors provided prefunctional tests and checklists.
9. Perform site visits, as necessary, to observe component and system installations. Attends selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
10. Witness all or part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify owner's representative of any deficiencies in results or procedures.
11. Witness all or part of any ductwork testing and cleaning procedures, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify owner's representative of any deficiencies in results or procedures.
12. Approve prefunctional tests and checklist completion by reviewing prefunctional checklist reports and by selected site observation and spot checking.
13. Approve systems startup by reviewing start-up reports and by selected site observation.
14. Review TAB execution plan.
15. Approve air and water systems balancing by spot testing, by reviewing completed reports and by selected site observation.
16. With necessary assistance and review from installing contractors, write the functional performance test procedures for equipment and systems. This may include energy management control system trending, stand-alone datalogger monitoring or manual functional testing. Submit to CM for review, and for approval if required.
17. Analyze any functional performance trend logs and monitoring data to verify performance.
18. Coordinate, witness and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
19. Maintain a master issues log and a separate testing record. Provide the CM and Owner with written progress reports and test results with recommended actions.
20. Witness performance testing of smoke control systems by others and all other owner contracted tests or tests by manufacturer's personnel over which the Cx may not have direct control. Document these tests and include this documentation in Commissioning Record in O&M manuals.
21. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
22. Oversee and approve the training of the Owner's operating personnel.
23. Compile and maintain a Commissioning Record and building Systems Manual.
24. Review and approve the preparation of the O&M manuals.
25. Provide a final commissioning report.
26. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.

27. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract .

1.14 SYSTEMS TO BE COMMISSIONED

- A. The following checked systems will be commissioned in this project.
 1. HVAC Systems
 - a. Packaged Rooftop Air Handling Units
 - b. Hot Water Piping
 - c. VAV Boxes
 - d. Cabinet Unit Heaters, Unit Heaters, and RCP
 - e. Low-Leak Automatic Control Dampers
 - f. Ductwork
 - g. Exhaust Fans
 - h. Glycol System
 - i. Variable Frequency Drives
 - j. Humidification & Dehumidification Systems
 - k. Building Automation System
 - l. TAB Services
 2. Electrical Systems
 - a. Emergency Lighting oversight
 - b. Occupancy Sensors (20% sampling)
 - c. Daylighting Controls oversight (20% sampling)
 3. Electronic Safety and Security Systems
 - a. Media Space Fire Alarm System oversight coordinated with JHA

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Division contractor for the equipment being tested.
- B. Special equipment, tools and instruments required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site, except for stand-alone datalogging equipment that may be used by the Cx.
- C. Datalogging equipment and software required to test equipment will be provided by the Cx but shall not become the property of the Owner.

- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the *Specifications*. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 MEETINGS

- A. Scoping Meeting. Within 90 days of commencement of construction, the Cx will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Information gathered from this meeting will allow the Cx to revise the *Commissioning Plan* to its "final" version, which will also be distributed to all parties.
- B. Miscellaneous Meetings (up to 2 total). Other meetings will be planned and conducted by the Cx as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The Cx will plan these meetings in conjunction with the owner and will minimize unnecessary time being spent by Subcontractors

3.2 REPORTING

- A. The Cx will provide regular reports to the CM and the owner, with increasing frequency as construction and commissioning progresses. Standard forms are provided and referenced in the Commissioning Plan.
- B. The Cx will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, field reports, and issues logs.
- C. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.
- D. A final summary report by the Cx will be provided to the Owner. This report will be an evaluation of the system commissioning issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report.

3.3 SUBMITTALS

- A. The Commissioning authority may review and provide comments on submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The Commissioning authority will notify the CM, Owner and or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.

- B. The Cx may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.
- C. These submittals to the Cx do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the Cx may review and approve them.
- D. Contractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the Commissioning Authority's review.

3.4 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment to be commissioned, according to Part 1, "Systems to be Commissioned".
- B. General. Prefunctional Tests and checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system. PFT test sheets are to be provided by factory representatives in coordination with the installation contractor.
- C. Start-up and Initial Checkout Plan. The Cx shall assist the team members responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the Cx in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for prefunctional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms.
 - 1. The Cx reviews the Contractors pre-functional checklists and procedures. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
 - 2. These checklists and tests are provided by the Contractor to the Cx. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form will have more than one trade responsible for its execution.
 - 3. The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the Contractor's checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. The full start-up plan could consist of something as simple as:
 - a. The Contractor's approved prefunctional checklists.
 - b. The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - c. The manufacturer's normally used field checkout sheets.
 - 4. The subcontractor submits the full startup plan to the Cx for review and approval.

5. The Cx reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
6. The full start-up procedures and the approval form may be provided to the CM for review and approval, depending on management protocol.

D. Sensor and Actuator Calibration.

1. All field-installed temperature, relative humidity, CO, CO₂ and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved by the Owner before-hand. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed *in* the unit at the factory with calibration certification provided need not be field calibrated.
2. All procedures used shall be fully documented on the prefunctional checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
3. Sensor Calibration Methods.
 - a. All Sensors. Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
 - b. Sensors without Transmitters-Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.
 - c. Sensors with Transmitters-Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
 - d. Critical Applications. For critical applications (process, manufacturing, etc.) more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.

Tolerances, Standard Applications

<u>Sensor</u>	<u>Required Tolerance (+/-)</u>	<u>Sensor</u>	<u>Required Tolerance (+/-)</u>
Cooling coil, chilled and condenser water temps	0.4F	Flow rates, water	4% of design
AHU wet bulb or dew point	2.0F	Relative humidity	4% of design
Hot water coil and boiler water temp	1.5F	Combustion flue temps	5.0F
Outside air, space air, duct air temps	0.4F	Oxygen or CO ₂ monitor	0.1 % pts
Watt-hour, voltage & amperage	1% of design	CO monitor	0.01 % pts
Pressures, air, water and gas	3% of design	Natural gas and oil flow rate	1% of design
Flow rates, air	10% of design	Steam flow rate	3% of design
		Barometric pressure	0.1 in. of Hg

4. Valve and Damper Stroke Setup and Check.

- a. EMS Readout. For all valve and damper actuator positions checked, verify the actual position against the BMS readout.
- b. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

5. Closure for heating coil valves (NO): Set heating setpoint 20°F above room temperature. Observe valve open. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set heating setpoint to 20°F below room temperature. Observe the valve close. For pneumatics, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

6. Closure for cooling coil valves (NC): Set cooling setpoint 20°F above room temperature. Observe the valve close. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling setpoint to 20°F below room temperature. Observe valve open. For pneumatics, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

E. Execution of Prefunctional Checklists and Startup.

1. Four weeks prior to startup, the Subs and vendors schedule startup and checkout with the CM and Cx. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
2. For lower-level components of equipment, (e.g., VAV boxes, sensors, controllers), the Cx may elect to observe a sampling of the prefunctional and start-up activities.
3. The Subs and vendors shall execute startup and provide the Cx with a signed and dated copy of the completed start-up and prefunctional tests and checklists.

4. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

F. Issues, Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the Cx within two days of test completion.
2. The Cx reviews the outstanding items and provides comment as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner and shall notify the Cx as soon as outstanding items have been corrected .
3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party. Refer to Part 3 herein for details.

3.5 FUNCTIONAL PERFORMANCE TESTING

- A. This sub-section applies to all commissioning functional testing for all divisions.
- B. The general list of equipment to be commissioned is found in Section 019113, Part 1.
- C. The parties responsible to execute each test are listed with each test in the applicable sections of Divisions 22, 23, and 26.
- D. Objectives and Scope. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
 1. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.
 2. Development of Test Procedures. Before test procedures are written, the Cx shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The Cx shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor responsible to execute a test, shall provide limited assistance to the Cx in developing the procedures review (answering questions about equipment, operation, sequences, etc.). Prior to execution, the Cx shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The Cx may submit the tests to the A/E for review, if requested.
 3. The Cx shall review owner-contracted, factory testing or required owner acceptance tests which the Cx is not responsible to oversee, including documentation format, and shall determine what further testing or format changes may be required to comply with the Specifications. Redundancy of testing shall be minimized.
 4. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.

5. Representative test formats and examples (not designed for this facility) are found in this section (019113). The test procedure forms developed by the Cx shall include (but not be limited to the following information:
 - a. System and equipment or component name(s)
 - b. Equipment location and ID number
 - c. Unique test ID number, and reference to unique prefunctional checklist and start-up documentation ID numbers for the piece of equipment
 - d. Date
 - e. Project name
 - f. Participating parties
 - g. A copy of the specific sequence of operations or other specified parameters being verified
 - h. Formulas used in any calculations
 - i. Required pre-test field measurements
 - j. Instructions for setting up the test.
 - k. Special cautions, alarm limits, etc.
 - l. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
 - m. Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
 - n. A section for comments
 - o. Signatures and date block for the Contractors and Cx

E. Test Methods.

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers.
2. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Over-rides. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
4. Simulated Signals. Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended instead of using the sensor to act as the signal generator via simulated conditions or overwritten values.
5. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout setpoint to be 2F above the current outside air temperature.
6. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during prefunctional testing.

7. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
8. Sampling. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. It is noted that no sampling by Subs is allowed in prefunctional checklist execution.
 - a. A common sampling strategy referenced in the Specifications as the “xx% Sampling—yy% Failure Rule” is defined by the following example.

xx = the percent of the group of identical equipment to be included in each sample.
yy = the percent of the sample that if failing, will require another sample to be tested.
 - b. The example below describes a 20% Sampling—10% Failure Rule.
 - 1) Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the “first sample.”
 - 2) If 10% (yy) of the units in the first sample fail the functional performance tests, test another 20% of the group (the second sample).
 - 3) If 10% of the units in the second sample fail, test all remaining units in the whole group.
 - 4) If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the Cx may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.
- F. Coordination and Scheduling. The Subs shall provide sufficient notice to the Cx regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The Cx will schedule functional tests through the CM and affected Subs. The Cx shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests.
 1. In general, functional testing is conducted after prefunctional testing and startup has been satisfactorily completed. The control system is sufficiently tested and approved by the Cx before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting, individual systems has been achieved, the interface or coordinated responses between systems is checked.
- G. Test Equipment. Refer to Section 019113, Part 2 for test equipment requirements.
- H. Problem Solving. The Cx will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the CM, Subs and A/E.

3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Documentation. The Cx shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the CM for review and approval and to the Subs for review. The Cx will include the filled out forms in the final Commissioning Record.
- B. Non-Conformance.
1. The Cx will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the CM.
 2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the Cx. In such cases the deficiency and resolution will be documented on the procedure form.
 3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Cx will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the CM.
 4. As tests progress and a deficiency is identified, the Cx discusses the issue with the executing contractor.
 - a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
 - 1) The Cx documents the deficiency and the Sub's response and intentions and they go on to another test or sequence. The Sub corrects the deficiency and notifies the Cx.
 - 2) The Cx reschedules the test and the test is repeated.
 - b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - 1) The deficiency shall be documented with the Sub's response and a copy given to the CM
 - 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.
 - 3) The Cx documents the resolution process.
 - 4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency. The Cx reschedules the test and the test is repeated until satisfactory performance is achieved.
 5. Cost of Retesting.
 - a. The cost for the *Sub* to retest a prefunctional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the CM.
 - b. For a deficiency identified, not related to any prefunctional checklist or start-up fault, the following shall apply: The Cx and CM will direct the retesting of the equipment once at no "charge" to the CM for their time. However, the Cx's time for a second retest will be charged to the CM, who may choose to recover costs from the responsible Sub.

- c. The time for the Cx and CM to direct any retesting required because a specific *prefunctional* checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged to the CM, who may choose to recover costs from the party responsible for executing the faulty prefunctional test.
 - d. Refer to the sampling section of Section 019113, Part 3 for requirements for testing and retesting identical equipment.
 - 6. The Contractor shall respond in writing to the Cx and CM] concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
 - 7. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.
- C. Failure Due to Manufacturer Defect. If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CM] or Owner's Representative. In such case, the Contractor shall provide the Owner with the following:
- 1. Within one week of notification from the CM or Owner's Representative, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CM or Owner's Representative within two weeks of the original notice.
 - 2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
 - 3. The CM or Owner's Representative will determine whether a replacement of all identical units or a repair is acceptable.
 - 4. Two examples of the proposed solution will be installed by the Contractor and the CM or Owner's Representative will be allowed to test the installations for up to one week, upon which the CM or Owner's Representative will decide whether to accept the solution.
 - 5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
- D. Approval. The Cx notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the Cx and by the CM, if necessary. The Cx recommends acceptance of each test to the CM using a standard form. The CM gives final approval on each test using the same form, providing a signed copy to the Cx and the Contractor.

3.7 DEFERRED TESTING

- A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the OR. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

- B. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The Cx shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the Cx witnessing. Any final adjustments to the O&M manuals and as-builds due to the testing will be made.

3.8 TRAINING OF OWNER PERSONNEL

- A. The CM shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.
- B. The Cx shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.
 - 1. The Cx shall interview the facility manager and lead engineer to determine the special needs and areas where training will be most valuable. The Owner and Cx shall decide how rigorous the training should be for each piece of commissioned equipment. The Cx shall communicate the results to the Subs and vendors who have training responsibilities. In addition to these general requirements, the specific training requirements of Owner personnel by Subs and vendors is specified in Division 22, 23, and 26.
 - 2. Each Sub and vendor responsible for training will submit a written training plan to the Cx for review and approval prior to training. The plan will cover the following elements:
 - a. Equipment (included in training)
 - b. Intended audience
 - c. Location of training
 - d. Objectives
 - e. Subjects covered (description, duration of discussion, special methods, etc.)
 - f. Duration of training on each subject
 - g. Instructor for each subject
 - h. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
 - i. Instructor and qualifications
 - j. For the primary HVAC equipment, the Controls Contractor shall provide a short discussion of the control of the equipment during the mechanical or electrical training conducted by others.
 - 3. The Cx develops an overall training plan and coordinates and schedules, with the CM, the overall training for the commissioned systems. The Cx develops criteria for determining that the training was satisfactorily completed, including attending some of the training, etc. The Cx recommends approval of the training to the CM using a standard form. Video recording of the training sessions will be provided by the Trade Contractor [

3.9 OPERATION AND MAINTENANCE MANUALS

- A. Standard O&M Manuals
 - 1. The specific content and format requirements for the standard O&M manuals are detailed in Division 1 section 017823

2. Contractor shall submit two draft copies of the complete operating and maintenance manual to the CM for review by the architect/engineer and Cx within 45 calendar days after review and approval of equipment shop drawings.
3. Contractor shall submit corrected final approved manuals 30 days prior to substantial completion. The Cx shall review the final O&M manuals and documentation, with redline as-builts, for systems that were commissioned to verify compliance with the specifications. The Cx will communicate, through the CM, deficiencies in the manuals to the contractor or A/E, as requested. Upon a successful review of the corrections, the Cx will recommend approval and acceptance of these sections of the O&M manuals to the CM. The Cx will also review each equipment warranty and verify that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.

B. Commissioning Record in O&M Manuals

1. The Cx is responsible to compile, and organize the following commissioning data, by system, into indexed three-ring binders and deliver to the Owner to be included in the O&M Manuals. The Commissioning Record shall include 5 main sections:
 - a. Commissioning Plan
 - b. Final Commissioning Report
 - c. Commissioning Testing Record
 - d. Training Record
 - e. Issues and Deficiencies Record
2. The Final Commissioning Report shall include:
 - a. Executive summary
 - b. List of participants and roles
 - c. Brief building description
 - d. Overview of commissioning and testing scope
 - e. General description of testing and verification methods.
3. The Commissioning Testing Record shall include:
 - a. Completed Prefunctional checklists and system startup forms provided by Contractors.
 - b. Completed functional performance testing forms for each system
4. The Training Record shall include:
 - a. Overall Training Plan
 - b. Sub and vendor written training plans
5. The Issues and Deficiencies Record shall include:
 - a. Open Items Listing
 - b. Closed Items Listing

3.10 WRITTEN WORK PRODUCTS

- A. The commissioning process generates a number of written work products described in various parts of the *Specifications*. The *Commissioning Plan—Construction Phase*, lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them. In summary, the written products are:

Product	Developed By
1. Final commissioning plan	Cx
2. Cx meeting minutes	Cx
3. Commissioning schedules	Cx with CM
4. Equipment documentation submittals	Subs
5. Sequence clarifications	EOR
5. Prefunctional checklists	Subs, presented to Cx
6. Startup and initial checkout plan	Subs and Cx (compilation of existing documents)
7. Startup and initial checkout forms filled out	Subs
8. Final TAB report	TAB
9. Issues log (deficiencies)	Cx
10. Commissioning Progress Record	Cx
11. Deficiency reports	Cx
12. Functional test forms	Cx
13. O&M manuals	Subs
14. Overall training plan oversight and approvals	Cx and CM
15. Specific training agendas	Subs
16. Misc. approvals	Cx

3.11 SAMPLES OF TYPICAL PRE-FUNCTIONAL TESTS AND CHECKLISTS

PRE-FUNCTIONAL TEST CHECKLIST

Form: _____ Date: _____

Project: _____

Location: _____

System: _____

Tested by: _____

Approved by: _____

Test Results:

Test Item	Pass/Fail	Notes
1. System is installed and configured correctly.	Pass	
2. System is tested and found to be functional.	Pass	
3. System is tested and found to be functional.	Pass	
4. System is tested and found to be functional.	Pass	
5. System is tested and found to be functional.	Pass	
6. System is tested and found to be functional.	Pass	
7. System is tested and found to be functional.	Pass	
8. System is tested and found to be functional.	Pass	
9. System is tested and found to be functional.	Pass	
10. System is tested and found to be functional.	Pass	
11. System is tested and found to be functional.	Pass	
12. System is tested and found to be functional.	Pass	
13. System is tested and found to be functional.	Pass	
14. System is tested and found to be functional.	Pass	
15. System is tested and found to be functional.	Pass	
16. System is tested and found to be functional.	Pass	
17. System is tested and found to be functional.	Pass	
18. System is tested and found to be functional.	Pass	
19. System is tested and found to be functional.	Pass	
20. System is tested and found to be functional.	Pass	

PRE-FUNCTIONAL TEST CHECKLIST

Form: _____ Date: _____

Project: _____

Location: _____

System: _____

Tested by: _____

Approved by: _____

Test Results:

Test Item	Pass/Fail	Notes
1. System is installed and configured correctly.	Pass	
2. System is tested and found to be functional.	Pass	
3. System is tested and found to be functional.	Pass	
4. System is tested and found to be functional.	Pass	
5. System is tested and found to be functional.	Pass	
6. System is tested and found to be functional.	Pass	
7. System is tested and found to be functional.	Pass	
8. System is tested and found to be functional.	Pass	
9. System is tested and found to be functional.	Pass	
10. System is tested and found to be functional.	Pass	
11. System is tested and found to be functional.	Pass	
12. System is tested and found to be functional.	Pass	
13. System is tested and found to be functional.	Pass	
14. System is tested and found to be functional.	Pass	
15. System is tested and found to be functional.	Pass	
16. System is tested and found to be functional.	Pass	
17. System is tested and found to be functional.	Pass	
18. System is tested and found to be functional.	Pass	
19. System is tested and found to be functional.	Pass	
20. System is tested and found to be functional.	Pass	

PRE-FUNCTIONAL TEST CHECKLIST

Form: _____ Date: _____

Project: _____

Location: _____

System: _____

Tested by: _____

Approved by: _____

Test Results:

Test Item	Pass/Fail	Notes
1. System is installed and configured correctly.	Pass	
2. System is tested and found to be functional.	Pass	
3. System is tested and found to be functional.	Pass	
4. System is tested and found to be functional.	Pass	
5. System is tested and found to be functional.	Pass	
6. System is tested and found to be functional.	Pass	
7. System is tested and found to be functional.	Pass	
8. System is tested and found to be functional.	Pass	
9. System is tested and found to be functional.	Pass	
10. System is tested and found to be functional.	Pass	
11. System is tested and found to be functional.	Pass	
12. System is tested and found to be functional.	Pass	
13. System is tested and found to be functional.	Pass	
14. System is tested and found to be functional.	Pass	
15. System is tested and found to be functional.	Pass	
16. System is tested and found to be functional.	Pass	
17. System is tested and found to be functional.	Pass	
18. System is tested and found to be functional.	Pass	
19. System is tested and found to be functional.	Pass	
20. System is tested and found to be functional.	Pass	

PRE-FUNCTIONAL TEST CHECKLIST

Form: _____ Date: _____

Project: _____

Location: _____

System: _____

Tested by: _____

Approved by: _____

Test Results:

Test Item	Pass/Fail	Notes
1. System is installed and configured correctly.	Pass	
2. System is tested and found to be functional.	Pass	
3. System is tested and found to be functional.	Pass	
4. System is tested and found to be functional.	Pass	
5. System is tested and found to be functional.	Pass	
6. System is tested and found to be functional.	Pass	
7. System is tested and found to be functional.	Pass	
8. System is tested and found to be functional.	Pass	
9. System is tested and found to be functional.	Pass	
10. System is tested and found to be functional.	Pass	
11. System is tested and found to be functional.	Pass	
12. System is tested and found to be functional.	Pass	
13. System is tested and found to be functional.	Pass	
14. System is tested and found to be functional.	Pass	
15. System is tested and found to be functional.	Pass	
16. System is tested and found to be functional.	Pass	
17. System is tested and found to be functional.	Pass	
18. System is tested and found to be functional.	Pass	
19. System is tested and found to be functional.	Pass	
20. System is tested and found to be functional.	Pass	

Functional Performance Test FPT-1 AIR HANDLING UNIT		System: AHU-1		
		Location of Equipment: MECHANICAL ROOM		
Servicing: FLOORS 1-5		Subsystems and/or Components: ☐ VFD ☐ VAV Boxes ☐ BMS		
Project Name: SAMPLE PROJECT				
Test Date/Time: AM/PM		PARTICIPANTS		
Weather:		NAME	COMPANY	DATE
O.A. Temp: °F	O.A. Humidity %RH			
☐ 1st Test	☐ Retest			
-----PASS/FAIL STATUS-----				
☐ Pass	☐ Fail	☐ Incomplete	☐ Retest Required	☐ Other
-----EQUIPMENT INFORMATION-----				
Manufacturer:		Volts:		
Model:		Amps:		
Serial No.:		Phase:		
Type/Size:		Misc Info:		

3.12 FUNCTIONAL PERFORMANCE TESTS (SAMPLES)

1. **PURPOSE AND SCOPE**

- To verify that the Air Handling Unit is visually inspected, mechanically inspected and functional to ensure it is in compliance with drawings and specifications.

2. **PROCEDURE**

- Upon completion of the installation of the Air Handling Unit and the completion of the pre-functional test procedures, perform the checks and inspections included in this form.
- Verify that any issues found prior to or during this inspection be assigned an issue number with a detailed description of each deficiency. Attach additional sheets as necessary.
- This checklist DOES NOT take the place of the Manufacturer's recommended start-up and checkout procedures or reports. Items that do not apply shall be checked as N/A (not applicable).
- Unless otherwise noted, release overrides for each numbered test procedure before starting the next numbered test procedure.

3. **SAFETY**

- All parties involved must be cognizant of applicable safety procedures.
- This document does not include any procedures, including specific safety procedures. It is recognized that an overwhelming majority of tests and inspections recommended are potentially hazardous.

- Individuals performing these tests shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved.

4. **SYSTEM OVERVIEW**-Brief overview of the systems is as follows:

This is an indoor **multiple-zone VAV system** serving the SE offices and hall. It has hot water heating and chilled water cooling, and field installed BMS controls with a VFD return fan. The system has full economizer capability. Return Air (RA), Outside Air (EA) & Exhaust Air (EA) dampers modulate to maintain slightly positive space. There is local perimeter baseboard heating along the east wall. *Fan Runs when unoccupied.* Sequence calls for MAT<55° or OAT=>RAT to end economizer; otherwise economizer modulates to maintain SAT.

Control Loops are: SAT (55-65°F, to satisfy warmest/most humid zone), SA fan speed (duct pressure), RF Speed (tracking supply from S&R flow stations), OA volume (= SAVol-RAvol & damper modulation) [1250 cfm to handle pressurization and exhaust bleed from REMP room]; and Space Relative Humidity (**Rh** sp=30%). [Morning warm-up (reset SAT to 85°F) and cool down (by OA or Mech cooling), both with Optimal start time calc are defined, but not used in practice because of continuous running. Zone sensor switches can call for night override for 90 mins of day space setpoints for all office zones and change to occupied setpoint. (Confirm that owner plans to use night setback setpoints).

5. **SENSOR CALIBRATION* CHECKS:** Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during prefunctional testing.

Control Point	BMS Reading	Measured Reading	Pass	Fail	Issue #	Date
Space Temperature Sensor (new)	°F	°F	☐	☐		
Supply Air Temperature Sensor (new)	°F	°F	☐	☐		
Min. O.A. CFM	%	°F	☐	☐		
Min. pos. O.A. Damper	%	°F	☐	☐		
Supply CFM Design Total: CFM	N/A	_CFM	☐	☐		

* The term "In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the prefunctional checklist requirements. If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

6. **OCCUPIED/UNOCCUPIED SETTINGS**

	SPECIFIED SCHEDULE		ACTUAL SCHEDULE		ISSUES	
Day of Week	Occupied	Unoccupied	Occupied	Unoccupied	Issue #	Date
Sunday	AM	PM	AM	PM		
Monday	AM	PM	AM	PM		
Tuesday	AM	PM	AM	PM		
Wednesday	AM	PM	AM	PM		
Thursday	AM	PM	AM	PM		
Friday	AM	PM	AM	PM		
Saturday	AM	PM	AM	PM		

REMARKS:

7. FUNCTIONAL PERFORMANCE TESTS-Record all of the following information into the tables below and assign an issue # to all items that have an issue.

1	Verify AHU OFF Mode	N/A	PAS S	FAIL	ISSU E	ISSU E #	DATE
a.	Outdoor air damper is closed.	☐	☐	☐	☐		
b.	Return air damper is open.	☐	☐	☐	☐		
c.	Supply, Exhaust Fan(s) are "off." Status indicates "off."	☐	☐	☐	☐		
d.	Heating coil valve controls to maintain a 45°F supply air temperature setpoint.	☐	☐	☐	☐		
e.	System Graphic Corresponds to Field Conditions.	☐	☐	☐	☐		

REMARKS:

2	Verify Availability of Air Handling System	N/A	PAS S	FAIL	ISSU E	ISSU E #	DATE
a.	AHU is enabled via the Building Management System (BMS) for two modes of operation: Occupied heating. Unoccupied heating.	☐	☐	☐	☐		
b.	Verify operation of the local override button on the temperature sensor.	☐	☐	☐	☐		
c.	Index the system to unoccupied, verify indexing to unoccupied mode.	☐	☐	☐	☐		
d.	Activate override button and verify that the system returns to the occupied mode of operation for a period of 30 minutes.	☐	☐	☐	☐		

REMARKS:

3	Verify Supply Fan Starting Sequences (Occupied Heating Mode)-Automatic Mode	N/A	PAS S	FAIL	ISSU E	ISSU E #	DATE
a.	Verify that the system starts via the BMS optimal routine with a weekly schedule of Monday thru Friday 7:30am – 3:00pm. Index the unit to start, verify that the supply and exhaust fan start. Record schedule.	☐	☐	☐	☐		
b.	Verify that the outside air damper modulates to 10% (adj.) open position with the associated return damper going to 10% closed position.	☐	☐	☐	☐		
c.	Verify that exhaust fan AF-15 is enabled "on" (subject to local override "off" switch) whenever AHU-11's supply fan is on.	☐	☐	☐	☐		

REMARKS:

4	Verify Occupied Outdoor (Ventilation) Air Control	N/A	PAS S	FAIL	ISSU E	ISSU E #	DATE
a.	Simulate an outside air temperature less than 70°F but greater 50°F, verify that the economizer is enabled.	☐	☐	☐	☐		
b.	Simulate an outside air temperature less than 70°F, verify that the economizer becomes disabled.	☐	☐	☐	☐		
c.	Simulate an outside air temperature greater than 50°F, verify that the economizer becomes disabled.	☐	☐	☐	☐		
d.	System graphic should correspond to field conditions.	☐	☐	☐	☐		

REMARKS:

5	Verify Occupied Mode, Economizer Enabled. Space Calling for Cooling	N/A	PAS S	FAIL	ISSU E	ISSU E #	DATE
a.	Simulate the space calling for cooling; verify that the units economizer is enabled, and the outside air damper modulates open, the return air damper modulates closed in unison with the outside air damper in order to maintain space temperature setpoint of 70°F.	☐	☐	☐	☐		

REMARKS:

6	Verify Occupied Mode, Economizer Enabled Space Calling for Heat	N/A	PAS S	FAIL	ISSU E	ISSU E #	DATE
a.	Simulate a space calling for heat; verify that the economizer is enabled, and the outside air damper modulates to minimum position, the return air damper modulates open in unison with the outside air damper and the heating valve modulates open in order to maintain a space temperature setpoint of 70°F.	☐	☐	☐	☐		

REMARKS:

7	Verify Occupied Mode, Economizer Disabled	N/A	PAS S	FAIL	ISSU E	ISSU E #	DATE
a.	Simulate space temperatures above and below space temperature setpoint; verify that the mixing dampers are locked at minimum position and the heating valve modulates in order to maintain space temperature setpoint.	☐	☐	☐	☐		

REMARKS:

8	Verify Unoccupied Heating (OAT < 50°F) Control	N/A	PAS S	FAIL	ISSUE	ISSU E #	DATE
	Index the system to the unoccupied mode.	☐	☐	☐	☐		
a.	Verify that both the supply and exhaust fans are “off,” and the heating coil valve modulates to maintain a supply air temperature setpoint of 45°F.	☐	☐	☐	☐		
b.	Simulate a room temperature of 54°F, verify that the supply fan starts and operates on 100% return air and the heating coil control valve drives open to satisfy the night setback temperature setpoint of 55°F.	☐	☐	☐	☐		
c.	Verify that the associated exhaust fan remains “off” when the supply fan cycles.	☐	☐	☐	☐		
d.	Verify that the system graphic corresponds to field conditions.	☐	☐	☐	☐		

REMARKS:

9	Verify AHU Safety Shutdown Sequences-Low Temperature Limit	N/A	PAS S	FAIL	ISSUE	ISSU E #	DATE
a.	Trip a low temperature limit sensor by applying ice on capillary tube. The entire fan system shall shutdown.	☐	☐	☐	☐		
b.	A low temperature alarm will annunciate at the BMS workstation.	☐	☐	☐	☐		
c.	Verify that the outdoor air damper is closed.	☐	☐	☐	☐		
d.	Verify that the return air damper is open.	☐	☐	☐	☐		
e.	The heating valve will open 100% during this condition.	☐	☐	☐	☐		
f.	The fan system will restart after alarm is manually reset.	☐	☐	☐	☐		
g.	System graphic corresponded to field conditions.	☐	☐	☐	☐		
h.	Repeat above steps with the system in its HAND mode.	☐	☐	☐	☐		

REMARKS:

10	System Smoke Detection	N/A	PAS S	FAIL	ISSUE	ISSU E #	DATE
a.	Verify that the existing smoke alarm system has remained intact.	☐	☐	☐	☐		
b.	Verify that the safety shuts down the system in both "automatic" and "hand" modes.	☐	☐	☐	☐		

REMARKS:**8. TRENDING INFORMATION**-Provide trend information for the following points:

Control Point Name	Type	Frequency	Duration
Fan Status	BI		
Space Temperature	AI		
Outside Air Temperature	AI		
Supply Air Temperature	AI		
Damper Position	AO		
Heating Coil Valve Position	AO		
Occ./Unocc.			

REMARKS:**9. ISSUES LOG**

ISSUE #	ISSUE DESCRIPTION	DATE	RECORDED BY	CORRECTION VERIFIED
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Functional Performance Test FPT-1 EXHAUST FAN		System: EF- 1		
		Location of Equipment: MECHANICAL ROOM		
Servicing: BATHROOMS		Subsystems and/or Components: ☐ BMS		
Project Name: SAMPLE PROJECT				
Test Date/Time: _____ AM/PM		PARTICIPANTS		
Weather:		NAME	COMPANY	DATE
O.A. Temp: °F	O.A. Humidity %RH			
☐ 1st Test	☐ Retest			
-----PASS/FAIL STATUS-----				
☐ Pass	☐ Fail	☐ Incomplete	☐ Retest Required	☐ Other
-----EQUIPMENT INFORMATION-----				
Manufacturer:		Volts:		
Model:		Amps:		
Serial No.:		Phase:		
Type/Size:		Misc Info:		

1. **PURPOSE AND SCOPE**

- To verify that the Exhaust Fan is visually inspected, mechanically inspected and functional to ensure it is in compliance with drawings and specifications.

2. **PROCEDURE**

- Upon completion of the installation of the Exhaust Fan and the completion of the pre-functional test procedures, perform the checks and inspections included in this form.
- Verify that any issues found prior to or during this inspection be assigned an issue number with a detailed description of each deficiency. Attach additional sheets as necessary.
- This checklist DOES NOT take the place of the Manufacturer's recommended start-up and checkout procedures or reports. Items that do not apply shall be checked as N/A (not applicable).
- Unless otherwise noted, release overrides for each numbered test procedure before starting the next numbered test procedure.

3. **SAFETY**

- All parties involved must be cognizant of applicable safety procedures.
- This document does not include any procedures, including specific safety procedures. It is recognized that an overwhelming majority of tests and inspections recommended are potentially hazardous.
- Individuals performing these tests shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved.

4. SYSTEM OVERVIEW-Brief overview of the systems is as follows:

This Functional Test of this exhaust fan (EF-1) will be conducted by van Zelm Heywood & Shadford, Inc. with the assistance of the installing Contractor(s) to ensure that the individual components are installed and integrated to operate on a system level per the design intent and sequence of operations.

5. AIRFLOW CHECKS: Record airflows as follows:

Fan Design CFM	Fan Actual CFM	Pass	Fail	Issue #	Date
_CFM	_CFM	☐	☐		

REMARKS:**6. OCCUPIED/UNOCCUPIED SETTINGS**

	SPECIFIED SCHEDULE		ACTUAL SCHEDULE		ISSUES	
Day of Week	Occupied	Unoccupied	Occupied	Unoccupied	Issue #	Date
Sunday	AM	PM	AM	PM		
Monday	AM	PM	AM	PM		
Tuesday	AM	PM	AM	PM		
Wednesday	AM	PM	AM	PM		
Thursday	AM	PM	AM	PM		
Friday	AM	PM	AM	PM		
Saturday	AM	PM	AM	PM		

REMARKS:**7. FUNCTIONAL PERFORMANCE TESTS**-Record all of the following information into the tables below and assign an issue # to all items that have an issue.

1	Fan Sequencing-Verify operation during <u>Occupied</u> Mode	N/A	PAS S	FAIL	ISSUE	ISSU E #	DATE
a.	Verify that the "BMS" schedules the unit occupied / unoccupied	☐	☐	☐	☐		
b.	Verify that when the unit is indexed to run, the motorized back-draft damper opens, when the damper end switch makes, verify that the exhaust fan starts.	☐	☐	☐	☐		
c.	Manually fail the exhaust fan, verify that an alarm has been set to the operator workstation.	☐	☐	☐	☐		

REMARKS:

8. TRENDING LOG REVIEW:

1	Review Trend Log for this fan	N/A	PAS S	FAIL	ISSU E	ISSU E #	DATE
a.	Does the fan cycle off based on the Occ/Unocc schedule?	☐	☐	☐	☐		

REMARKS:**9. ISSUES LOG**

ISSUE #	ISSUE DESCRIPTION	DATE	RECORDED BY	CORRECTION VERIFIED
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

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END OF SECTION 019113

SECTION 024119 - SELECTIVE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
 - 2. Salvage of existing items to be reused or recycled.

- B. Related Requirements:

- 1. Section 011000 "Summary of Work" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
 - 2. Section 017300 "Execution" for cutting and patching procedures.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Remove and Replace: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled. Provide and install new items as specified.
- E. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- F. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PRE-INSTALLATION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Pre-demolition Photographs: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.
- E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- F. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract. Contractor will be required to coordinate with Owner's vendor.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:
 - 1. Ballasted, Single-Ply Roofing by Tremco, Inc.**
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.11 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
 - 1. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- D. Survey of Existing Conditions: Record existing conditions by use of measured drawings and pre-construction photographs.
 - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
 - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.

- c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. All removed materials and rubbish shall be constantly sprinkled with water or other dusting agent to mitigate dust. Provide drop cloths or other type of coverings to prevent infiltration of dust to other parts of the existing building.
10. Dispose of demolished items and materials promptly.

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- B. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.

3.8 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 035416 - HYDRAULIC CEMENT UNDERLAYMENT

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 polymer-modified, self-leveling, hydraulic cement underlayment.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans indicating substrates, locations, and average depths of underlayment based on survey of substrate conditions.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment products required for this Project.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.
 - 1. Place hydraulic cement underlayments only when ambient temperature and temperature of substrates are between 50 and 80 deg F.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 HYDRAULIC CEMENT UNDERLAYMENTS

- A. Hydraulic Cement Underlayment: Polymer-modified, self-leveling, hydraulic cement product that can be applied in minimum uniform thickness of ¼-inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Basis-of-Design:
 - a. Ardex Americas; **Ardex K 520**
 - 2. Acceptable Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bostik, Inc.
 - b. Euclid Chemical Company (The)
 - c. Koster Corporation
 - d. Mapei Corporation
 - e. Maxxon Corporation
 - f. USG Corporation
 - g. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
 - 3. Cement Binder: ASTM C 150, Portland cement, or hydraulic or blended hydraulic cement as defined by ASTM C 219.
 - 4. Compressive Strength: Not less than 5,500 psi at twenty-eight (28) days when tested according to ASTM C 109.
- B. Aggregate: Well-graded, washed gravel, 1/8- to ¼-inch; or coarse sand as recommended by underlayment manufacturer.
 - 1. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.
- C. Water: Potable and at a temperature of not more than 70 deg F.
- D. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.
- E. Surface Sealer: Designed to reduce porosity as recommended by manufacturer for type of floor covering to be applied to underlayment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for conditions affecting performance of the Work.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Prepare and clean substrate according to manufacturer's written instructions.
 - 1. Treat non-moving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.

2. Fill substrate voids to prevent underlayment from leaking.
 - B. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.
 1. Moisture Testing: Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates do not exceed a maximum moisture-vapor-emission rate of 3 lb. of water/1000 sq. ft. in 24 hours.
 - C. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.
- 3.3 APPLICATION
- A. General: Mix and apply underlayment components according to manufacturer's written instructions.
 1. Close areas to traffic during underlayment application and for time period after application recommended in writing by manufacturer.
 2. Coordinate application of components to provide optimum adhesion to substrate and between coats.
 3. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.
 - B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
 - C. Apply underlayment to produce uniform, level surface.
 1. Apply a final layer without aggregate to product surface.
 2. Feather edges to match adjacent floor elevations.
 - D. Cure underlayment according to manufacturer's written instructions. Prevent contamination during application and curing processes.
 - E. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.
 - F. Apply surface sealer at rate recommended by manufacturer.
 - G. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.
- 3.4 PROTECTION
- A. Protect underlayment from concentrated and rolling loads for remainder of construction period.

END OF SECTION 035416

SECTION 042200 - CONCRETE UNIT MASONRY

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. Concrete masonry units.
 - 2. Mortar and grout.
 - 3. Steel reinforcing bars.
 - 4. Masonry-joint reinforcement.
 - 5. Miscellaneous masonry accessories.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - 2. Cementitious materials. Include name of manufacturer, brand name, and type.
 - 3. Pre-blended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 4. Grout mixes. Include description of type and proportions of ingredients.
 - 5. Reinforcing bars.

- 6. Joint reinforcement.
- 7. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

- 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109 for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
- 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.
- D. Deliver pre-blended, dry mortar mix in moisture-resistant containers. Store pre-blended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three (3) days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.3 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide bullnose units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.

1. Density Classification: Normal weight.
2. Size (Width): Manufactured to dimensions 3/8-inch less-than-nominal dimensions.

2.4 MASONRY LINTELS

- A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure pre-cast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207, Type S.

C. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4-inch-thick, use aggregate graded with one hundred percent (100%) passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

D. Aggregate for Grout: ASTM C 404.

E. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615 or ASTM A 996, Grade 60.

- B. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A 951.

1. Interior Walls: Hot-dip galvanized carbon steel.
2. Wire Size for Side Rods: 0.148-inch diameter.
3. Wire Size for Cross Rods: 0.148-inch diameter.
4. Spacing of Cross Rods: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.7 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1½ inches into masonry but with at least a 5/8-inch cover on outside face.

- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Stainless-Steel Wire: ASTM A 580, Type 304.
 2. Stainless-Steel Sheet: ASTM A 240 or ASTM A 666, Type 304.
- C. Partition Top Anchors: 0.105-inch-thick metal plate with a 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from stainless-steel.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to thirty-five percent (35%); of width and thickness indicated; formulated from closed cell PVC.
- B. Pre-formed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.9 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
 2. Use Portland cement-lime mortar unless otherwise indicated.
- B. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated.
1. For reinforced masonry, use Type S.
 2. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
 3. For interior non-load-bearing partitions, Type O may be used instead of Type N.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C 476, Table 1.
 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 - 2. Verify that reinforcing dowels are properly placed.
 - 3. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation, do not vary by more than plus ½-inch or minus ¼-inch.
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus ½-inch.
 - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus ¼-inch in a story height or ½-inch total.
- B. Lines and Levels:
 - 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than ¼-inch in 10 feet, or ½-inch maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8-inch in 10 feet, ¼-inch in 20 feet, or ½-inch maximum.
 - 3. For vertical lines and surfaces, do not vary from plumb by more than ¼-inch in 10 feet, 3/8-inch in 20 feet, or ½-inch maximum.
 - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8-inch in 10 feet, ¼-inch in 20 feet, or ½-inch maximum.
 - 5. For lines and surfaces, do not vary from straight by more than ¼-inch in 10 feet, 3/8-inch in 20 feet, or ½-inch maximum.
 - 6. For vertical alignment of exposed head joints, do not vary from plumb by more than ¼-inch in 10 feet, or ½-inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8-inch, with a maximum thickness limited to 1/2-inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8-inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8-inch or minus 1/4-inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8-inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8-inch.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 1. Install compressible filler in joint between top of partition and underside of structure above.
 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
 3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

4. At fire-rated partitions, treat joint between top of partition and underside of structure.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 2. Bed webs in mortar in grouted masonry.
- B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8-inch on exterior side of walls, 1/2-inch elsewhere. Lap reinforcement a minimum of 6 inches.
 1. Space reinforcement not more than 16 inches o.c.
 2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 1. Install pre-formed control-joint gaskets designed to fit standard sash block.

3.8 LINTELS

- A. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.9 REINFORCED UNIT MASONRY INSTALLATION

- A. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

- B. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than 60 inches.

3.10 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level C in TMS 402/ACI 530/ASCE 5.
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Frequency: One (1) set of tests for each 5000-sq. ft. of wall area or portion thereof.
- D. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
- F. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.
- G. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.11 CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.12 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

- B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

SECTION 055000 - METAL FABRICATIONS

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. Steel framing and supports for mechanical and electrical equipment.
 - 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Fasteners.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connection. Show anchorage and accessory items.
- C. Provide Shop Drawings for the following:
 - 1. Steel framing and supports for mechanical and electrical equipment.
 - 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Research Reports: For post-installed anchors.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1, "Structural Welding Code - Steel."

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F 3125, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A 563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.
- E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Capable of sustaining, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and four (4) times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E 488, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- H. Post-Installed Anchors: Torque-controlled expansion anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless-Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Division 09 painting sections.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Pre-assemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32-inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated, coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1½ inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
- C. Galvanize miscellaneous steel framing and supports where indicated.

2.7 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153 for steel and iron hardware and with ASTM A 123 for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 REPAIRS

- A. Touchup Painting:
 - 1. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 sections.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

SECTION 061000 - ROUGH CARPENTRY

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. Wood blocking and nailers.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- C. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. SPIB: The Southern Pine Inspection Bureau.
 - 3. NLGA: National Lumber Grades Authority.
 - 4. WWPAA: Western Wood Products Association.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 - 3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- B. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preservative-treated wood.
 - 2. Power-driven fasteners.
 - 3. Powder-actuated fasteners.

4. Post-installed anchors.
5. Expansion anchors.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

- B. Maximum Moisture Content of Lumber: Nineteen percent (19%) unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

- B. Kiln-dry lumber after treatment to a maximum moisture content of nineteen percent (19%). Do not use material that is warped or that does not comply with requirements for untreated material.

- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

- D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping and similar concealed members in contact with masonry or concrete.

2.3 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.

- B. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any of the following species:
 - 1. Hem-fir (north); NLGA.
 - 2. Hem-fir; WCLIB or WWPA.
 - 3. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
- C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.4 FASTENERS

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless-steel.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC193 as appropriate for the substrate.
 - 1. Material: Stainless-steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six (6) times the load imposed when installed in unit masonry assemblies and equal to four (4) times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.5 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025-inch.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Do not splice structural members between supports unless otherwise indicated.
- C. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- D. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use copper naphthenate for items not continuously protected from liquid water.
- E. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- F. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
 - 3. ICC-ES evaluation report for fastener.
- G. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

END OF SECTION 061000

SECTION 062023 - INTERIOR FINISH CARPENTRY

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 trim, etc.
 - 2. Shelving.

- B. Related Requirements:

- 1. Section 061000 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.
 - 2. Section 099123 "Interior Painting" for priming and backpriming of interior finish carpentry.
 - 3. Section 099300 "Staining and Transparent Finishing" for staining and finishing of interior finish carpentry.

1.3 COORDINATION

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Show large-scale details.
 - 3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
 - 4. Show locations and sizes of cutouts and holes for items installed in architectural woodwork.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation.
 - 1. Protect materials from weather by covering with waterproof sheeting, securely anchored.
 - 2. Provide for air circulation around stacks and under coverings.
- B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 INTERIOR ARCHITECTURAL WOODWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

2.2 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by inspection agency.
- B. Hardboard: AHA A135.4.

- C. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.

2.3 INTERIOR WOODWORK

- A. Hardwood Lumber for Transparent Finish (Stain or Clear Finish):
 - 1. Species and Grade: White maple; NHLA A Finish as a minimum.
 - 2. Maximum Moisture Content: Ten percent (10%).
 - 3. Finger Jointing: Not allowed.
 - 4. Gluing for Width: Not allowed.
 - 5. Veneered Material: Allowed.
 - 6. Face Surface: Surfaced (smooth).
 - 7. Matching: Selected for compatible grain and color.

2.4 SHELVING AND CLOTHES RODS

- A. Exposed Shelving: Made from the following material, ¾-inch-thick:
 - 1. Wood boards as specified above for hardwood lumber trim for transparent finish.
- B. Standards for Adjustable Shelf Brackets: BHMA A156.9, B04102; zinc-plated steel.
- C. Adjustable Shelf Brackets: BHMA A156.9, B04112; zinc-plated steel.

2.5 MISCELLANEOUS MATERIALS

- A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
 - 1. For applications not otherwise indicated, provide stainless-steel fasteners.
- B. Adhesives: Do not use adhesives that contain urea formaldehyde.
 - 1. Multi-purpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.
 - a. Adhesive shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FABRICATION

- A. Back out or kerf backs of the following members except those with ends exposed in finished work:
 - 1. Interior standing and running trim, except crown molds.
- B. Ease edges of lumber less than 1-inch in nominal thickness to 1/16-inch radius and edges of lumber 1-inch or more in nominal thickness to 1/8-inch radius.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours.
- C. Prime to be painted, including both faces and edges, unless factory primed. Cut to required lengths and prime ends. Comply with requirements in Section 099123 "Interior Painting."

3.3 INSTALLATION, GENERAL

- A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, too small to fabricate with proper jointing arrangements, or with defective surfaces, sizes, or patterns.
- B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials.
 - 1. Use concealed shims where necessary for alignment.
 - 2. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 3. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
 - 4. Install to tolerance of 1/8-inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
 - 5. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 STANDING AND RUNNING TRIM INSTALLATION

- A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available.
 - 1. Do not use pieces less than 24 inches long, except where necessary.
 - 2. Stagger joints in adjacent and related standing and running trim.
 - 3. Miter at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint.
 - 4. Use scarf joints for end-to-end joints.
 - 5. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
 - 6. Install trim after gypsum-board joint finishing operations are completed.

7. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting.
8. Fasten to prevent movement or warping.
9. Countersink fastener heads on exposed carpentry work and fill holes.

3.5 INSTALLATION OF SHELVING AND CLOTHES RODS

- A. Install standards for adjustable shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches o.c. and within 6 inches of ends of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
- B. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled.
 1. Install shelves, fully seated on cleats, brackets, and supports.

3.6 ADJUSTING

- A. Replace interior finish carpentry that is damaged or does not comply with requirements.
 1. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.
- B. Adjust joinery for uniform appearance.

3.7 CLEANING

- A. Clean interior finish carpentry on exposed and semi-exposed surfaces.
- B. Restore damaged or soiled areas and touch up factory-applied finishes, if any.

3.8 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023

SECTION 064116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

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. Plastic-laminate-clad architectural cabinets and panels.
 - 2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-faced architectural cabinets unless concealed within other construction before cabinet installation.
 - 3. Cabinetry and casework hardware and accessories.
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets and concealed within other construction before cabinet installation.

1.3 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Show details full size.
 - 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
- C. Samples:

1. Plastic laminates, 12 by 12 inches, for each type, color, pattern, and surface finish required.
 - a. Provide one (1) sample applied to core material with specified edge material applied to one (1) edge.
2. Corner pieces as follows:
 - a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. Miter joints for standing trim.
3. Exposed cabinet hardware and accessories, one (1) unit for each type and finish.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Certificates: For the following:
 1. Composite wood products.
 2. High-pressure decorative laminate.
 3. Adhesives.
- C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.7 QUALITY ASSURANCE

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

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction and indicate measurements on Shop Drawings.

- C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of cabinets indicated for construction, finishes, installation, and other requirements.
- B. Grade: **Custom**.
- C. Type of Construction: Frameless.
- D. Door and Drawer Front Interface Style: Reveal overlay.
 - 1. Reveal Dimension: ½-inch, unless otherwise indicated.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.
 - 1. Basis-of-Design:
 - a. Abet Laminati, Inc.
 - b. Wilsonart International; Div. of Premark International, Inc.
 - 2. 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. Arborite
 - b. Formica Corporation
 - c. Lab Designs
 - d. Lamin-Art, Inc.
 - e. Lamitech
 - f. Nevamar, a division of Panolam Industries International, Inc.
 - 3. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- F. Laminate Cladding for Exposed Surfaces:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Vertical Surfaces: Grade HGS.
 - 3. Edges: PVC edge banding, 0.12-inch-thick, matching laminate in color, pattern, and finish.
 - 4. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.
- G. Materials for Semi-Exposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.

- a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12-inch-thick, matching laminate in color, pattern, and finish.
 - b. For semi-exposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
 - 2. Drawer Sides and Backs: Solid-hardwood lumber.
 - 3. Drawer Bottoms: Hardwood plywood.
 - H. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
 - I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with glued dovetail joints.
 - J. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. **PL**, as indicated in Section 090000 "Schedule of Finishes".
- 2.2 WOOD MATERIALS
- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content: Five to ten percent (5-10%).
 - B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
 - 2. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.
- 2.3 CABINET HARDWARE AND ACCESSORIES
- A. Butt Hinges: 2¾-inch, five-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:
 - 1. Semi-Concealed Hinges for Overlay Doors: BHMA A156.9, B01521.
 - B. Wire Pulls: Back-mounted, solid metal, 4 inches long, 5/16-inch in diameter.
 - C. Catches: Roller catches, BHMA A156.9, B03071.
 - D. Shelf Rests (Pins): BHMA A156.9, B04013; metal.
 - E. Drawer Slides: BHMA A156.9.
 - 1. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): Side mount.
 - a. Type: Full overtravel extension type.
 - b. Material: Zinc-plated-steel ball-bearing slides.

- c. Motion Feature: Self-closing mechanism.
 - 2. General-purpose drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide Grade 1HD-100 with 75-lb. capacity.
 - 3. File drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-200 with 100-lb. capacity.
- F. Door Locks: BHMA A156.11, E07121.
- 1. Sized for cabinet thickness on the active leaf as indicated in the documents, with two (2) keys master keyed all alike to keys of adjacent manufactured laboratory casework, with manufacturer's standard finger operated sash lock on the adjacent inactive leaf (in double door applications). For bidding purposes, the Contractor shall assume that one hundred percent (100%) of all cabinet operating door leaves or pairs of doors shall be locked.
- G. Drawer Locks: BHMA A156.11, E07041.
- 1. Sized for drawer thickness, with two (2) keys master keyed all alike to keys of adjacent manufactured laboratory casework. For bidding purposes, the Contractor shall assume that one hundred percent (100%) of all drawers shall be locked.
- H. Door and Drawer Silencers: BHMA A156.16, L03011.
- I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
- 1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
 - 2. Satin Stainless-Steel: BHMA 630.
- J. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.
- 2.4 MISCELLANEOUS MATERIALS
- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, fire-retardant-treated where required, kiln dried to less than fifteen percent (15%) moisture content.
 - B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use non-ferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
 - C. Adhesives: Do not use adhesives that contain urea formaldehyde.
 - 1. Adhesive for Bonding Plastic Laminate: Contact cement, water based.
 - a. Adhesive for Bonding Edges: Polyurethane hot-melt adhesive.
- 2.5 FABRICATION
- A. Fabricate cabinets to dimensions, profiles, and details indicated.
 - B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for

shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to average humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

- A. Grade: Install cabinets to comply with quality standard grade of items to be installed.
- B. Assemble cabinets and complete fabrication at Project site to the extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
 1. Use filler matching finish of items being installed.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8-inch in 96 inches using concealed shims.
 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 2. Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1½-inch penetration into wood framing, blocking, or hanging strips or No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

3.3 ADJUSTING AND CLEANING

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

- C. Clean cabinets on exposed and semi-exposed surfaces.

END OF SECTION 064116

SECTION 078413 - PENETRATION FIRESTOPPING

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. Fireproof firestopping and firesafing materials and accessories.

1.3 PERFORMANCE REQUIREMENTS

- A. Fireproofing Materials: ASTM E 119 and ASTM E 814 to achieve a fire rating as noted on Drawings.
- B. Surface Burning: ASTM E 84 with a flame spread/fuel contributed/smoke developed rating of 5/0/0.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated provide characteristics, performance, and limitation criteria.
- B. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience.
- B. Applicator: Company specializing in performing the work of this Section with minimum five (5) years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable State Building code for fire resistance ratings and surface burning characteristics.
- B. UL Classifications for these systems shall be (all two (2) hours or more):
 - 1. Duct Penetrations: C-AJ-7027
 - 2. Pipe Penetrations: C-AJ-1079
 - 3. Cable Penetrations: C-AJ-1079
 - 4. Conduit Penetrations: C-AJ-1079

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply materials when temperature of substrate material and ambient air is below 60 degrees F.
- B. Maintain this minimum temperature before, during and for three (3) days after installation of materials.
- C. Provide ventilation in areas to receive solvent cured materials.

1.8 SEQUENCING

- A. Sequence Work to permit firestopping materials to be installed after adjacent and surrounding work is complete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Thermal Ceramics; **Firemaster Putty, Bulk, and Blankets**
- B. Tremco Incorporated; **Fyre-shield and Cerablanket FS Hilti, Inc.**
- C. United States Gypsum; **Thermafiber Safing Insulation and FIRECODE compound**
- D. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.2 MATERIALS

- A. Firestopping Material: Single component silicone elastomeric compounds; conforming to the following:
 - 1. Elongation & Shrinkage: Five percent (5%).
 - 2. Tensile Strength: 300 psi.
 - 3. Density: 8 lb/cu ft.
 - 4. Surface Durability: 35 (Shore Hardness).
 - 5. Durability and Longevity: Permanent.
 - 6. Side Effects during Installation: Non-toxic.
 - 7. Long Term Side Effects: None.
- B. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces.
- C. Firesafing Blankets: ASTM C 665; 4 psf nominal density firesafing insulation.
- D. Putty Pads: UL CLIV; acoustic, intumescent pad; 3.2mm thickness.

2.3 ACCESSORIES

- A. Dam Material: Mineral fiber matting, permanent.
- B. Retainers: Stainless clips to support mineral fiber matting

2.4 FINISHES

- A. Color: Dark gray or manufacturer's standard color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Install backing materials to arrest liquid material leakage.

3.3 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Apply firestopping material to all wall and floor penetrations through rated assemblies. These penetrations include electrical conduit and raceways, plumbing and heating system penetrations, ducts, and other system chases.
- C. Apply primer and materials in accordance with manufacturer's instructions.
- D. Apply firestopping material in sufficient thickness to achieve rating to a density of fifty percent (50%) to uniform density and texture.
- E. Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit, and other items requiring firestopping.
- F. Remove dam material after firestopping material has cured.

3.4 CLEANING AND PROTECTION

- A. Clean off excess materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.5 SCHEDULE

- A. See Construction Documents for rating information and construction details and conditions.
- B. Firesafe all penetrations through new and existing masonry and gypsum board construction in the project work areas, equal to the one (1) or two (2) hour rating of the appropriate spaces.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

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. Silicone joint sealants.
 - 2. Latex joint sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- C. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
 - 2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Two (2) years from date of Substantial Completion.
- B. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:
 1. Architectural sealants shall have a VOC content of 250 g/L or less.
- C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- D. Stain-Test-Response Characteristics: Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- E. Colors of Exposed Joint Sealants: As selected by Architect and Owner from manufacturer's entire range, to match adjacent where required.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, Non-Staining: Non-staining, paintable, single-component, non-sag, plus fifty percent (+50%) and minus fifty percent (-50%) movement capability, non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Products:
 - a. Dow Corning Corporation
 - b. Master Bond, Inc.
 - c. Pecora Corporation
 - d. Tremco Incorporated
 - e. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.3 LATEX JOINT SEALANTS

- A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Building Systems
 - b. Bostik, Inc.
 - c. Pecora Corporation
 - d. Tremco Incorporated
 - e. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.4 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type B (bi-cellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Non-porous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent non-porous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean non-porous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Non-porous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Non-Sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
 - 4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
 - 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces.
 - 1. Joint Locations:

- a. Joints between different materials.
 - b. Other Joints as indicated.
- 2. Joint Sealant: Silicone, paintable, non-staining, S, NS, 50, NT.
- B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces.
 - 1. Joint Locations:
 - a. Perimeter joints of exterior openings where indicated.
 - b. Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
 - c. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
 - d. Other joints as indicated.
 - 2. Joint Sealant: Latex.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

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 hollow-metal work.
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors and frames.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
- C. Samples: For units with factory-applied color finishes.
- D. Product Schedule: For hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
- B. Deliver welded frames with two (2) removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

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. Ceco Door Products; an ASSA ABLOY Group company
 - 2. Curries Company; an ASSA ABLOY Group company
 - 3. Steelcraft; an Allegion company
 - 4. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.3 INTERIOR DOORS AND FRAMES

- A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3.
 - 1. Physical Performance: Level A according to SDI A250.4.
 - 2. Doors:
 - a. Basis-of-Design:

1) Steelcraft; an Allegion company; **L Series**

- b. Type: As indicated in the Door and Frame Schedule.
- c. Thickness: 1¾ inches.
- d. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 16-gauge.
- e. Edge Construction: Model 2, Seamless.
- f. Core: Manufacturer's standard Kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.

3. Frames:

- a. Materials: Uncoated, steel sheet, minimum thickness of 16-gauge.
- b. Construction: Full profile welded.

4. Exposed Finish: Prime.

2.4 BORROWED LITES

- A. Fabricate of uncoated steel sheet, minimum thickness of 16-gauge.
- B. Construction: Face welded.
- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 - 2. Quantity: Minimum of three (3) anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one (1) additional anchor for each 24 inches of frame height above 7 feet.
 - 3. Post-Installed Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A 879, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008 or ASTM A 1011; hot-dip galvanized according to ASTM A 153, Class B.

2.6 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153.
- C. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- D. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143.
- E. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- F. Glazing: Comply with requirements in Section 088000 "Glazing".
- G. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.7 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
 - 1. Fire Door Cores: As required to provide fire-protection ratings indicated.
 - 2. Vertical Edges for Single-Acting Doors: Bevel edges 1/8-inch in 2 inches.
 - 3. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.
 - 4. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
- C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 4. Floor Anchors: Weld anchors to bottoms of jambs with at least four (4) spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
 - 5. Jamb Anchors: Provide spacing of anchors as follows:

- a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing.
 - b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c.
 - c. Post-Installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
- 6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three (3) door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two (2) door silencers.
- D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce frames to receive non-templated, mortised, and surface-mounted door hardware.
 - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- F. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
 - 1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
 - 2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
 - 3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 - 4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.8 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.9 ACCESSORIES

- A. Grout Guards: Formed from same material as frames, not less than 0.016-inch-thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with SDI A250.11 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - g. Field apply bituminous coating to backs of frames that will be filled with grout containing anti-freezing agents.
 - h. Solidly pack mineral-fiber insulation inside frames.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 4. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
 5. In-Place Concrete Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 6. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16-inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16-inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16-inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16-inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.
1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

END OF SECTION 081113

SECTION 087100 - DOOR HARDWARE

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. Mechanical door hardware for the following:
 - a. Swinging doors.

- B. Related Sections:

- 1. Section 064116 "Plastic-Laminate-Faced Architectural Cabinets" for cabinet door hardware provided with cabinets.
 - 2. Section 081113 "Hollow Metal Doors and Frames" for door silencers provided as part of hollow-metal frames.

1.3 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Inspect and discuss preparatory work performed by other trades.
 - 3. Review required testing, inspecting, and certifying procedures.

1.5 ACTION SUBMITTALS

- A. **ALL DOOR HARDWARE MUST BE SUBMITTED UNDER A SINGLE SUBMITTAL PACKAGE, REGARDLESS OF DOOR MATERIAL.**
- B. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- C. Samples: For each exposed product in each finish specified, in manufacturer's standard size.
 - 1. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- D. Door Hardware Schedule: Prepared by or under the supervision of Installer. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Shop Drawings, and Samples. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 - 2. Format: Use same scheduling sequence and format and use same door numbers as in the door hardware schedule in the Contract Documents.
 - 3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Fastenings and other pertinent information.
 - e. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
 - f. Mounting locations for door hardware.
 - g. List of related door devices specified in other Sections for each door and frame.
- E. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- C. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware and keying schedule.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedules.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 2. Warranty Period: Three (3) years from date of Substantial Completion, unless otherwise indicated.
 - a. Exit Devices: Two (2) years from date of Substantial Completion.
 - b. Manual Closers: Ten (10) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
- B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.
- C. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with ICC/ANSI A117.1.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than ½-inch-high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a point 3 inches (12 degrees) from the latch.

2.3 SCHEDULED DOOR HARDWARE

- A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.
 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products, where allowed.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:
 1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements.

2.4 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
 1. Basis-of-Design:
 - a. Ives, an Allegion company; **5BB1**
 2. 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. Hager Companies
 - b. McKinney Products Company, an ASSA ABLOY Group company
 - c. Stanley Commercial Hardware, a division of Dormakaba
 - d. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.5 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in Part 3 "Door Hardware Schedule".
- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 1. Bored Locks: Minimum ½-inch latchbolt throw.
 2. Mortise Locks: Minimum ¾-inch latchbolt throw.
- C. Lock Backset: 2¾ inches, unless otherwise indicated.

- D. Lock Trim:
 - 1. Levers: Cast.
 - a. Construction: Freewheeling vandal resistant.
 - 2. Escutcheons (Roses): Wrought.
- E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
 - 1. Flat-Lip Strikes: For locks with three-piece anti-friction latchbolts, as recommended by manufacturer.
- F. Bored Locks: BHMA A156.2; Grade 1; Series 4000.
 - 1. Basis-of-Design:
 - a. Schlage Commercial Lock Division, an Allegion company; **ND Series – Sparta, Vandigard** functions
 - 2. 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. Dormakaba Group
 - b. SARGENT Manufacturing Company; an ASSA ABLOY Group company
 - c. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- G. Mortise Locks: BHMA A156.13; Security Grade 1; stamped steel case with steel or brass parts; Series 1000.
 - 1. Basis-of-Design:
 - a. Schlage Commercial Lock Division; an Allegion company; **LM9200 Series – 17, Vandigard** functions
 - 2. 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. Dormakaba Group
 - b. SARGENT Manufacturing Company; an ASSA ABLOY Group company
 - c. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.6 EXIT DEVICES AND AUXILIARY ITEMS

- A. Exit Devices and Auxiliary Items: BHMA A156.3.
 - 1. Basis-of-Design Product:
 - a. Von Duprin; an Allegion company; **Series 99L, 996/06** trim
 - 2. 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. Dormakaba Group
- b. SARGENT Manufacturing Company; an ASSA ABLOY Group company
- c. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

- B. Coordinate exit device operation with cylinder locks where specified.
- C. Interior panic hardware shall be cut ½ width of door from latch side only.
- D. All exit devices shall be provided with cylinder dogging hardware for manual keying.
- E. At paired exit device doors, provide keyed removable mullions similar to Von Duprin steel mullion, **Model #9954**.

2.7 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless-steel, or nickel silver.
 - 1. Manufacturer: Same manufacturer as for keying.
- B. Standard Lock Cylinders: BHMA A156.5; Grade 1; permanent cores that are removable; face finished to match lockset.

2.8 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Incorporate decisions made in keying conference.
 - 1. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders to match existing keying system.
- B. Keys: Brass.
 - 1. Quantity: In addition to one (1) extra key blank for each lock, provide the following:
 - a. Great-Grand Master Keys: Five (5).

2.9 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 - 1. Basis-of-Design Product:
 - a. LCN; an Allegion company; **4040XP Series**
 - 2. 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. Dormakaba Group
 - b. SARGENT Manufacturing Company, an ASSA ABLOY Group company
 - c. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

- B. Door closers to have delayed action cylinder, sized to the door leaf size.
 - 1. Marked closer/stop, shall be **Cush** series shall have positive stop built in.
- C. Door closers are to be mounted on the least conspicuous side of the door. The hardware supplier shall consult with the Architect to verify applications and note mounting locations on the hardware schedule.

2.10 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16; polished cast brass, bronze, or aluminum base metal.
 - 1. Basis-of-Design:
 - a. IVES Hardware, an Allegion company; **407** and **436** or **438**
 - 1) Provide wall bumpers wherever possible. Provide floor stops where the use of wall bumpers is not feasible, provided the location of the stop is not a stumbling hazard or would cause the door to rack at the hinges.
 - 2. 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. Burns Manufacturing Incorporated
 - b. Rockwood Manufacturing Company, an ASSA ABLOY Group company
 - c. Substitutions: In accordance with Section 012500 "Substitution Procedures".

2.11 SMOKE SEALS

- A. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke ratings indicated, based on testing according to UL 1784.
 - 1. Basis-of-Design Products:
 - a. Pemko Manufacturing Co., an ASSA ABLOY Group company
 - 1) Smoke Rated Doors:
 - a) Head and Jamb: **S88C**, compression bulb
 - b) Meeting Stiles: **S772D**
 - c) Sill: **411APKL**, automatic door bottom
 - 2) Fire Rated Doors: Provided by the door manufacturer.
 - 2. 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. Reese Enterprises, Inc.
 - b. Zero International, an Allegion company
 - c. Substitutions: In accordance with Section 012500 "Substitution Procedures".

2.12 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
 - 1. Basis-of-Design Product:
 - a. National Guard Products; **427**
 - 2. 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. Pemko Manufacturing Co., an ASSA ABLOY Group company
 - b. Zero International, an Allegion company
 - c. Substitutions: In accordance with Section 012500 "Substitution Procedures".

2.13 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick stainless-steel, beveled edges; with manufacturer's standard machine or self-tapping screw fasteners.
 - 1. Basis-of-Design Product:
 - a. IVES Hardware, an Allegion company; **Series 8400**
 - 2. 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. Burns Manufacturing Incorporated
 - b. Rockwood Manufacturing Company, an ASSA ABLOY Group company
 - c. Substitutions: In accordance with Section 012500 "Substitution Procedures".
- B. All plates are 2 inches less width of door on single doors, 1-inch less width of door on pairs.
 - 1. Kick Plates: 16 inches high.

2.14 AUXILIARY DOOR HARDWARE

- A. Auxiliary Hardware: BHMA A156.16.
 - 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. Hager Companies
 - b. Rockwood Manufacturing Company, an ASSA ABLOY Group company
 - c. Stanley Commercial Hardware, a division of Dormakaba
 - d. Substitutions: In accordance with Section 012500 "Substitution Procedures".

2.15 FABRICATION

- A. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

- B. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Fire-Rated Applications:
 - a. Wood or Machine Screws: For the following:
 - 1) Strike plates to frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:
 - 1) Surface hinges to doors.
 - 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.
 - c. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

2.16 FINISHES

- A. Provide finishes complying with BHMA A156.18. Unless otherwise specified in the hardware sets or specification, materials and finishes for the buildings shall be as follows:
 - 1. BHMA 626 or 630 as a minimum, but to match existing.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one (1) hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with removable cores as indicated in keying schedule.
- E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- F. Stops: Provide wall or floor stops for doors unless other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 1. Do not notch perimeter gasketing to install other surface-applied hardware.
- H. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- I. Door Bottoms: Apply to bottom of door, forming seal with threshold/saddle when door is closed.

3.4 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.5 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, provide six (6) months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

3.7 DOOR HARDWARE SCHEDULE

- A. Provide hardware as specified in the previous articles in sets according to the following schedule and as indicated in the Door Schedule on the Drawings.
- B. The hardware supplier shall meet with the Architect and/or Owner to determine lock functions and keying requirements.

HW-1**EACH TO HAVE:**

BUTTS
 2 EXIT DEVICES (EXIT ONLY)
 1 REMOVABLE MULLION
 2 CLOSER/STOPS
 2 KICK PLATES
 1 THRESHOLD
 SMOKE SEALS

DOOR: 130.4**HW-3****EACH TO HAVE:**

BUTTS
 1 CLASSROOM LOCKSET
 1 STOP
 1 KICK PLATE
 SILENCERS

DOOR: 129, 131.1, 132**HW-2****EACH TO HAVE:**

BUTTS
 2 2-POINT CLASSRM SECURITY LOCKSET
 2 CLOSER/STOPS
 2 KICK PLATES
 1 THRESHOLD
 SMOKE SEALS

DOOR: 130.1**HW-4****EACH TO HAVE:**

1 FLOOR STOP
 BALANCE TO REMAIN

DOOR: 100

END OF SECTION 087100

SECTION 088000 - GLAZING

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. Glass for doors, frames, and interior borrowed lights.
 - 2. Glazing sealants and accessories.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations according to ASTM C 1036.
- C. IBC: International Building Code.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
- C. Glazing Accessory Samples: For gaskets and sealants, in 12-inch lengths. Install sealant Samples between two (2) strips of material representative in color of the adjoining framing system.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installers, glass testing agency and sealant testing agency.
- B. Product Test Reports: For tinted glass, coated glass, insulating glass, glazing sealants, and glazing gaskets.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

- C. Pre-construction adhesion and compatibility test report.
- D. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- C. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.8 PRE-CONSTRUCTION TESTING

- A. Pre-construction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
 - 1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
 - 2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
 - 3. Test no fewer than eight (8) Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
 - 4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F.

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage

or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: Ten (10) years from date of Substantial Completion.

- B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: Ten (10) years from date of Substantial Completion.

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. Cardinal Glass Industries
 2. DuPont™ Building Innovations
 3. McGrory Glass, Inc.
 4. Oldcastle BuildingEnvelope
 5. PPG Industries, Inc.
 6. Viracon, Inc.
 7. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
1. Design Wind Pressures: As indicated on Drawings and per Building Code, whichever is most stringent.
 2. Maximum Lateral Deflection: For glass supported on all four (4) edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1-inch, whichever is less.
- C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 4. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
- D. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 2. For uncoated glass, comply with requirements for Condition A.
 3. For coated vision glass, comply with requirements for Condition C (other coated glass).

2.5 FIRE-RESISTANCE-RATED GLAZING

- A. Fire-Resistance-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-resistance ratings indicated, based on testing according to ASTM E 119 or UL 263.
- B. Fire-Resistance-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, that the glazing is approved for use in walls, and the fire-resistance rating in minutes.
- C. Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, clear float glass; with intumescent interlayers; complying with testing requirements in 16 CFR 1201 for Category II materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGC (distributed by McGrory Glass); **Pyrobel**
 - b. Pilkington Group Limited (distributed by Technical Glass Products); **PyroStop**
 - c. Vetrotech Saint-Gobain – Fire-Rated Glass & Systems; **Contraflam**
 - d. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

2.6 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one (1) of the following:
 - 1. EPDM complying with ASTM C 864.
 - 2. Silicone complying with ASTM C 1115.
 - 3. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
 - 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.
- C. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

2.7 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 4. Colors of Exposed Glazing Sealants: As selected by Architect and Owner from manufacturer's full range, to match adjacent.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; **790**
 - b. Pecora Corporation; **890**
 - c. Tremco Incorporated; **Spectrem 1**
 - d. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.8 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, one hundred percent (100%) solids elastomeric tape; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.

2.9 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

- G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.10 FABRICATION

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
 - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge

damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one (1) continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.

- G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove non-permanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four (4) days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 FILM SCHEDULE

- A. Glass Type **GL-0**: Not used.

3.9 MONOLITHIC-GLASS SCHEDULE

- A. Glass Type **GL-1**: Not used.
- B. Glass Type **GL-2**: Clear fully tempered float glass.
 - 1. Thickness: ¼-inch.
 - 2. Safety glazing required.

- C. Glass Type **GL-3**: Not used.

- D. Glass Type **GL-4**: Not used.

3.10 LAMINATED GLASS SCHEDULE

- A. Glass Type **GL-5**: Not used.
- B. Glass Type **GL-7**: Not used.
- C. Glass Type **GL-22**: Not used.
- D. Glass Type **GL-46**: Not used.

3.11 INSULATING-GLASS SCHEDULE

- A. Glass Type **GL-9**: Not used.
- B. Glass Type **GL-10**: Not used.
- C. Glass Type **GL-11**: Not used.
- D. Glass Type **GL-12**: Not used.
- E. Glass Type **GL-13**: Not used.
- F. Glass Type **GL-14**: Not used.
- G. Glass Type **GL-15**: Not used.
- H. Glass Type **GL-16**: Not used.
- I. Glass Type **GL-18**: Not used.
- J. Glass Type **GL-20**: Not used.

- K. Glass Type **GL-25**: Not used.
- L. Glass Type **GL-26**: Not used.
- M. Glass Type **GL-32**: Not used.
- N. Glass Type **GL-36**: Not used.
- O. Glass Type **GL-42**: Not used.
- P. Glass Type **GL-43**: Not used.

3.12 INSULATING-LAMINATED-GLASS TYPES

- A. Glass Type **GL-17**: Not used.
- B. Glass Type **GL-19**: Not used.
- C. Glass Type **GL-21**: Not used.
- D. Glass Type **GL-23**: Not used.
- E. Glass Type **GL-27**: Not used.
- F. Glass Type **GL-28**: Not used.
- G. Glass Type **GL-29**: Not used.
- H. Glass Type **GL-30**: Not used.
- I. Glass Type **GL-31**: Not used.
- J. Glass Type **GL-41**: Not used.

3.13 FIRE-RESISTANCE-RATED GLAZING TYPES

- A. Glass Type **GL-6**: Not used. Fire-rated glazing with 450 deg F temperature rise limitation; laminated glass with intumescent interlayers.
- B. Glass Type **GL-8**: Not used.
- C. Glass Type **GL-24**: Not used.
- D. Glass Type **GL-33**: Not used.

END OF SECTION 088000

FLOORS:**CPT-1**

Item: Modular Washable Carpet
Manufacturer: J+J Flooring
Collection: Kinetex
Style: Tri-Plex II
Color: Wise Men
Size: 24" x 24"
Thickness: 0.205 Inches
Location: Refer to Finish Plan
Notes: Quarter Turn; Refer to Section 096813
Local Rep: Forrest Haskins 860.881.1540

CPT-2

Item: Modular Washable Carpet
Manufacturer: J+J Flooring
Collection: Kinetex
Style: Tri-Plex II
Color: Decker
Size: 24" x 24"
Thickness: 0.205 Inches
Location: Refer to Finish Plan
Notes: Quarter Turn; Refer to Section 096813
Local Rep: Forrest Haskins 860.881.1540

CPT-3

Item: Modular Washable Carpet
Manufacturer: J+J Flooring
Collection: Kinetex
Style: Tri-Plex II
Color: Mile Limit
Size: 24" x 24"
Thickness: 0.205 Inches
Location: Refer to Finish Plan
Notes: Quarter Turn; Refer to Section 096813
Local Rep: Forrest Haskins 860.881.1540

LVT-1

Item: Luxury Vinyl Tile
Manufacturer: J+J Flooring
Collection: Into the Woods
Style: Recharge
Color: Serenity
Size: 9" x 48"
Thickness: 5mm
Location: Refer to Finish Plan
Notes: Ashlar; Refer to Section 096519
Local Rep: Forrest Haskins 860.881.1540

LVT-2

Item: Luxury Vinyl Tile
Manufacturer: J+J Flooring
Collection: Multiple Choices
Style: Segment
Color: Fragments
Size: 18" x 36"

Thickness:	5mm
Location:	Refer to Finish Plan
Notes:	Parquet; Certified; Refer to Section 096519
Local Rep:	Forrest Haskins 860.881.1540
PFT-1	
Item:	Porcelain Floor Tile
Manufacturer:	Daltile
Style:	Volume 1.0
Color:	Sonic White VL75
Size:	12" x 12"
Thickness:	5/16"
Grout:	1/8" Thick; Laticrete 90 Light Pewter
Location:	Refer to Finish Plan & Finish Schedule
Notes:	Glazed w/StepWise Technology; Refer to Section 093000
Local Rep:	Cleo Galanos 203.233.8585
PFT-2	
Item:	Porcelain Floor Tile
Manufacturer:	Daltile
Style:	Volume 1.0
Color:	Amplify Black VL70
Size:	12" x 24"
Thickness:	5/16"
Grout:	1/8" Thick; Laticrete 90 Light Pewter
Location:	Refer to Finish Plan & Finish Schedule
Notes:	Glazed w/StepWise Technology; Provide and install anodized aluminum edge-protection at transition from new to existing floor tile; Refer to Section 093000
Local Rep:	Cleo Galanos 203.233.8585
PFT-3	
Item:	Porcelain Floor Tile
Manufacturer:	Daltile
Style:	Portfolio Vivid
Color:	Generation Z Yellow PF22
Size:	12" x 24" – Cut to 12" x 12" for Floor Pattern, Cut to 4" x 12" for Wall Base (Cap w/Anodized Aluminum Edge Profile at Exposed Top Edge)
Thickness:	5/16"
Grout:	1/8" Thick; Laticrete 90 Light Pewter
Location:	Refer to Finish Plan & Finish Schedule
Notes:	Slip-Resistant; Refer to Section 093000
Local Rep:	Cleo Galanos 203.233.8585
VCT-1	
Item:	Vinyl Composite Tile
Manufacturer:	Armstrong
Style:	Standard Excelon Imperial Texture
Color:	51906 Teal
Size:	12" x 12"
Thickness:	1/8"
Location:	Non-Library Classroom; Refer to Finish Plan & Finish Schedule
Notes:	Refer to Section 096519
Local Rep:	Jared Mallet 860.455.3901

VCT-2

Item: Vinyl Composite Tile
Manufacturer: Armstrong
Style: Standard Excelon Imperial Texture
Color: 51908 Pewter
Size: 12" x 12"
Thickness: 1/8"
Location: Corridor; Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 096519
Local Rep: Jared Mallet 860.455.3901

BASE:**RB-1**

Item: Rubber Wall Base
Manufacturer: Tarkett/Johnsonite
Style: Duracove Roll
Color: Black 40
Size: 6"H
Thickness: 1/8"
Location: General Wall Base
Notes: Refer to Section 096513
Local Rep: Amy Bloomberg 646.734.2623

RB-2

Item: Rubber Wall Base
Manufacturer: Tarkett/Johnsonite
Style: Duracove Roll
Color: Black 40
Size: 4"H
Thickness: 1/8"
Location: Non-Library Classroom/Corridor
Notes: Refer to Section 096513
Local Rep: Amy Bloomberg 646.734.2623

RB-3

Item: Rubber Wall Base
Manufacturer: Tarkett/Johnsonite
Style: Duracove Roll
Color: Dream Teal VM5
Size: 6"H
Thickness: 1/8"
Location: Podcast
Notes: Refer to Section 096513
Local Rep: Amy Bloomberg 646.734.2623

RB-4

Item: Rubber Wall Base
Manufacturer: Tarkett/Johnsonite
Style: Duracove Roll
Color: Gecko VN3
Size: 6"H
Thickness: 1/8"
Location: Recording
Notes: Refer to Section 096513
Local Rep: Amy Bloomberg 646.734.2623

RB-5

Item: Rubber Wall Base
Manufacturer: Tarkett/Johnsonite
Style: Duracove Roll
Color: Either Ore 66
Size: 4"H
Thickness: 1/8"
Location: Library Directors' Office
Notes: Refer to Section 096513
Local Rep: Amy Bloomberg 646.734.2623

WALLS:**WC-1**

Item: Acoustic Wall Covering
Manufacturer: Wolf-Gordon
Style: Felted
Color: Butterscotch GOH 34053512
Content: 100% Polyester
Roll Width: 63"W
Thickness: 3mm
NRC: 0.2
Location: Refer to Finish Plan & Elevations
Notes: Straight Hang, Random Match; Refer to Section 097200
Local Rep: Lisa Spencer 845.641.1081

WC-2

Item: Wall Covering
Manufacturer: Wolf-Gordon
Style: Wink Magnetic
Content: 100% Polyethylene Face on Cloth Backing
Finish: Gloss Sheen UV Coating
Size: 48" W
Location: Refer to Finish Plan & Elevations
Notes: Refer to Section 101146
Local Rep: Lisa Spencer 845.641.1081

CEILINGS:**ACT-1**

Item: Acoustical Ceiling Tile
Manufacturer: Armstrong
Style: Calla Templok
Color: White
Size: 2' x 2'
NRC: 0.85
LRV: 0.85
Location: Refer to RCP & Finish Schedule
Notes: PCM Technology (May Qualify for Up To 50% In Tax Credits);
 Mold/Mildew Resistant; Humidity Resistant; Square Lay-In; Prelude
 15/16"; Refer to Section 095113
Local Rep: Julie Wilson 959.236.4361

COATINGS:**PT-1E**

Item: Wall Paint
Manufacturer: Sherwin Williams
Color: SW 7006 Extra White

Finish: Eg-Shell
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

PT-1F

Item: Ceiling Paint
Manufacturer: Sherwin Williams
Color: SW 7006 Extra White
Finish: Flat
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

PT-1S

Item: Trim Paint
Manufacturer: Sherwin Williams
Color: SW 7006 Extra White
Finish: Semi-Gloss
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

PT-2E

Item: Accent Wall Paint
Manufacturer: Benjamin Moore
Color: 433 Forest Hills Green
Finish: Eg-Shell
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Allyson Smith 203.501.8541

PT-2S

Item: Trim Paint
Manufacturer: Benjamin Moore
Color: 433 Forest Hills Green
Finish: Semi-Gloss
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Allyson Smith 203.501.8541

PT-3E

Item: General Wall Paint
Manufacturer: Sherwin Williams
Color: SW 9165 Gossamer Veil
Finish: Eg-Shell
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

PT-3S

Item: General Wall Paint
Manufacturer: Sherwin Williams
Color: SW 9165 Gossamer Veil
Finish: Semi-Gloss
Location: Refer to Finish Plan & Finish Schedule

Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

PT-4

Item: Accent Wall Paint
Manufacturer: Sherwin Williams
Color: SW 9020 Rayo de Sol
Finish: Eg-Shell
Location: Refer to RCP & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

PT-5

Item: Accent Wall Paint
Manufacturer: Sherwin Williams
Color: SW 7068 Grizzle Gray
Finish: Eg-Shell
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

PT-6 Not Used**PT-7E**

Item: Accent Wall Paint
Manufacturer: Sherwin Williams
Color: SW 6494 Lakeshore
Finish: Eg-Shell
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

PT-7S

Item: Trim Paint
Manufacturer: Sherwin Williams
Color: SW 6494 Lakeshore
Finish: Semi-Gloss
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

PT-8 Not Used**PT-9**

Item: General Wall Paint
Color: Match Existing Classroom/Corridor Paint In-Kind
Finish: Eg-Shell
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123

PT-10

Item: Trim Paint
Color: Match Existing Classroom/Corridor Trim Paint In-Kind
Finish: Semi-Gloss
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123

PT-11

Item: Trim Paint
Manufacturer: Sherwin Williams
Color: SW 7069 Iron Ore
Finish: Semi-Gloss
Location: Refer to Finish Plan & Finish Schedule
Notes: Refer to Section 099123
Local Rep: Stuart Millstein 201.846.6558

CASEWORK:**PL-1**

Item: Plastic Laminate
Manufacturer: Abet Laminati
Color: Blu Acciaio 856
Finish: SEI (Standard)
Location: Vertical Surfaces at Casework
Notes: Refer to Sections 064116
Local Rep: Chris Armstrong 781.541.5062

PL-2

Item: Plastic Laminate
Manufacturer: Wilsonart
Color: Studio Teak
Finish: 7960K-18 Linearity Finish
Location: Vertical Surfaces at Casework
Notes: AEON Scratch Resistance; Refer to Sections 064116
Local Rep: Rick Walden 518.415.6270

SS-1

Item: Solid Surface
Manufacturer: Corian
Color: Willow
Location: Horizontal Surfaces at Casework
Notes: Refer to Section 123661.16
Local Rep: Dennis Labonte 959.599.1050

MISCELLANEOUS:**AWP-1**

Item: Acoustic Wall Panel
Manufacturer: Acoufelt
Style: WoodBeQuiet Slats 8"
Color: Natural Oak
Size: 48" x 110"
Thickness: 12mm
Locations: Refer to Finish Schedule
Notes: Direct applied with heavy-duty construction adhesive; NRC 0.45;
Refer to Section 098433
Local Rep: Sabrina Truan 800.966.8557

AWP-2

Item: Acoustic Wall Panel
Manufacturer: Turf Design
Style: Reed 2" Profile
Color: Grasshopper
Overall Size: Refer to Elevations
Thickness: 9mm

Locations:	Refer to Finish Schedule
Notes:	Cuts Must Align w/Edge of a Reed Flute; Provide Felt Caps and Flat-Fill w/Adhesive as Required for Installation; Hang with Z-clips and CMU screws at walls; NRC 0.90; Refer to Section 098433
Local Rep:	Jamie Persampieri 203.592.7498
AWP-3	
Item:	Acoustic Wall Panel
Manufacturer:	Turf Design
Style:	Reed 2" Profile
Color:	Cyan
Overall Size:	Refer to Elevations
Thickness:	9mm
Locations:	Refer to Finish Schedule
Notes:	Cuts Must Align w/Edge of a Reed Flute; Provide Felt Caps and Flat-Fill w/Adhesive as Required for Installation; Hang with Z-clips and CMU screws at walls; NRC 0.90; Refer to Section 098433
Local Rep:	Jamie Persampieri 203.592.7498
FTS-1	
Item:	Aluminum Threshold
Manufacturer:	Pemko
Model:	1719
Location:	To Be Used at Transition from Corridor Tile to LVT or CPT
FTS-2	
Item:	Transition
Manufacturer:	Profilitec
Style:	Trimtec TR45ASF270
Finish:	AS – Silver Anodized Aluminum
Location:	To Be Used at Transitions from CPT to LVT
Notes:	Refer to Section 096513
Local Rep:	Joe Rolston 732.503.0343
FTS-3	
Item:	Transition
Manufacturer:	Profilitec
Style:	TRIMTEC TR80AS270
Size:	5/16"
Finish:	AS – Silver Anodized Aluminum
Location:	To Be Used at Transitions from Existing Tile to PFT
Notes:	Refer to Section 096513
Local Rep:	Joe Rolston 732.503.0343
FTS-4	
Item:	Transition
Manufacturer:	Profilitec
Style:	Trimtec TR30ASF270
Finish:	AS – Silver Anodized Aluminum
Location:	To Be Used at Transitions from Existing VCT to VCT
Notes:	Refer to Section 096513
Local Rep:	Joe Rolston 732.503.0343
MS-1	
Item:	Metal Lettering
Manufacturer:	PHOTOMETALS – A Division of PMA Industries

Font: Franklin Gothic Demi Condensed
Color: Standard Paint
Size: 12"H x ½"D
Location: Viewing Corridor
Notes: Refer to Door & Finish Schedules; Refer to Section 101419
Local Rep: Ray Rider 602.607.4172

TB-1

Item: Tack Board
Manufacturer: Wolf Gordon
Style: Bulletin Board Cork Colored
Color: Baby Lettuce
Size: Refer to Elevations
Location: Refer to Drawings
Notes: Anodized Aluminum Protective Edge Trim on All Exposed Sides;
Refer to Section 101100
Local Rep: Lisa Spencer 845.641.1081

WB-1

Item: White Board
Color: White
Size: Refer to Elevations
Location: Refer to Drawings
Notes: Magnetic Porcelain; Refer to Section 101100

WS-1

Item: Manual Roller Window Shade
Manufacturer: Rollease Acmeda
Style: Ambient Renew 5% Openness
Color: R002 White/Beige
Location: PVC Free; All Rooms w/Exterior Windows & Interior Rooms as
Indicated in Drawings; Refer to Interior Elevations
Notes: Refer to Section 122413

WS-2

Item: Motorized Roller Window Shade
Manufacturer: Rollease Acmeda
Style: Ambient Renew 5% Openness
Color: R002 White/Beige
Location: PVC Free; Clerestory Windows; Refer to Interior Elevations
Notes: Refer to Section 122413

END OF SECTION 090000

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 for interior partitions.
 - 2. Suspension systems for interior ceilings and soffits.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS

- A. 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, G60, hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C 645.
 - 1. Steel Studs and Tracks:
 - a. Minimum Base-Metal Thickness: 20-gauge, unless noted otherwise.
 - b. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide the following:
 - 1. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) ClarkDietrich; **MaxTrak Slotted Deflection Track**
 - 2) MarinoWare; **Slotted Track**
 - 3) MBA Building Supplies; **Slotted Deflecto Track**
 - 4) Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.2 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.
- B. Wire Hangers: ASTM A 641, Class 1 zinc coating, soft temper, 0.16 -inch in diameter.
- C. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053-inch and minimum ½-inch-wide flanges.
 - 1. Depth: As indicated on Drawings. As required per manufacturer.

2.3 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.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install 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 spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Install studs so flanges within framing system point in same direction.
- C. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames.
 - a. Install two (2) studs at each jamb unless otherwise indicated.
 - b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8-inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

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

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

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 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.
- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.4 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.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, 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, those that are moisture damaged, and those that are 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.
- 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 GYPSUM BOARD, GENERAL

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

2.3 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Georgia-Pacific Gypsum LLC
 - 2. National Gypsum Company
 - 3. USG Corporation
 - 4. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- B. Abuse-Resistant Gypsum Board: ASTM C 1629.
 - 1. Core: Regular, unless otherwise indicated on Drawings.
 - 2. Surface Abrasion: Meets or exceeds Level 3 requirements.
 - 3. Surface Indentation: Meets or exceeds Level 1 requirements.
 - 4. Single-Drop Soft-Body Impact: Meets or exceeds Level 1 requirements.
 - 5. Long Edges: Tapered.
 - 6. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
 - 7. All gypsum board is to be abuse-resistant unless otherwise noted.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 - 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.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

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. Fry Reglet Corp.
 - b. Gordon, Inc.
 - c. Pittcon Industries
 - d. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
3. Finish: Mill.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Pre-filling: 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 drying-type, all-purpose compound.
 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. 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-thick.
- C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- D. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Pecora Corporation; **AC-20 FTR**
 - b. Specified Technologies, Inc.; **Smoke N Sound Acoustical Sealant**
 - c. USG Corporation; **SHEETROCK Acoustical Sealant**
 - d. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
- 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 (1) framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16-inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 2. Fit gypsum panels around ducts, pipes, and conduits.
 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow ¼- to 3/8-inch-wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide ¼- to ½-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets and boards are readily installed after panels have been installed on one (1) side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels in most economical direction, with ends and edges occurring over firm bearing unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one (1) framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 - 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

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.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners, unless otherwise indicated.
 - 2. Bullnose Bead: Use at outside corners.
 - 3. LC-Bead: Use at exposed panel edges.
 - 4. L-Bead: Use where indicated.
 - 5. U-Bead: Use at exposed panel edges.
- D. Aluminum Trim: Install in locations indicated on Drawings.

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. Pre-fill 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, receiving wallcoverings and flat and non-flat paints.
 - a. Primer and its application to surfaces are specified in Division 09 Sections.

3.6 PROTECTION

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

END OF SECTION 092900

SECTION 093000 - TILING

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. Porcelain tile.
 - 2. Crack isolation membrane.
 - 3. Metal edge strips.

- B. Related Sections:

- 1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

- 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.5 ACTION SUBMITTALS

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

- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

- C. Samples:

- 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Full-size units of each type of trim and accessory for each color and finish required.
 - 3. Metal edge strips in 6-inch lengths.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For tile-setting and -grouting products.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to three percent (3%) of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to three percent (3%) of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer employs installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
 - 2. Obtain crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
 - 1. Crack isolation membrane.
 - 2. Metal edge strips.

2.2 PRODUCTS, GENERAL

- A. ANSI Tile Standard: Provide tile that complies with Standard grade requirements for types, compositions, and other characteristics indicated.
 - 1. Ceramic: ANSI A137.1.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one (1) package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

2.3 TILE PRODUCTS

- 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. AKDO
 - 2. American Olean; a division of Dal-Tile International, Inc.
 - 3. Creative Materials Corp.
 - 4. Crossville, Inc.
 - 5. Daltile; a division of Dal-Tile International, Inc.
 - 6. Garden State Tile
 - 7. Marazzi USA
 - 8. Mosa
 - 9. New Jersey Tile & Stone, a member of the Olympia Tile Group
 - 10. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- C. Tile Type (**PFT**): Glazed porcelain floor tile.
 - 1. Basis-of-Design Product:
 - a. Daltile; a division of Dal-Tile International, Inc.; **Volume 1.0, Portfolio Vivid**

2. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
3. Face: Plain with square or cushion edges.
4. Dynamic Coefficient of Friction: ASTM C 1028.
 - a. Wet: Not less than 0.42.
5. Size, Thickness, Tile Color and Pattern, and Grout Color: As indicated in Section 090000 "Schedule of Finishes".

2.4 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Chlorinated Polyethylene Sheet: Non-plasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Noble Company (The); **Nobleseal CIS**
 - b. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.5 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4; white unless otherwise indicated.
 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. Bostik, Inc.
 - b. Custom Building Products
 - c. Laticrete International, Inc.
 - d. MAPEI Corporation
 - e. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
 2. Provide pre-packaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 3. For wall applications, provide mortar that complies with requirements for non-sagging mortar in addition to the other requirements in ANSI A118.4.

2.6 GROUT MATERIALS

- A. Basis-of-Design Product:
 1. Laticrete International, Inc.
- B. 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. Bostik, Inc.
 2. Custom Building Products
 3. MAPEI Corporation

4. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

C. Water-Cleanable Epoxy Grout: ANSI A118.3.

1. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F and 212 deg F, respectively, and certified by manufacturer for intended use.
2. Colors: As indicated in Section 090000 "Schedule of Finishes".

2.7 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, Portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

- B. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for wall applications; anodized aluminum, satin finish, exposed-edge material.

1. Basis-of-Design Product:

- a. Schluter Systems L.P.; **Jolly**

2. 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. Blanke Corporation
- b. Ceramic Tool Company, Inc.
- c. Profilitec Corp.
- d. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

- D. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints and that does not change color or appearance of grout.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Bostik, Inc.; **CeramaSeal Grout & Tile Sealer**
- b. Custom Building Products; **Surfaceguard Sealer**
- c. MAPEI Corporation; **KER003, Silicone Spray Sealer for Cementitious Tile Grout**
- d. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.8 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

- B. Add materials, water, and additives in accurate proportions.

- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one (1) package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Floor Tile: 1/8-inch.
- H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- I. Metal Edge Strips: Install at locations indicated by designation in Section 090000 "Schedule of Finishes".
- J. Grout Sealer: Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.5 CLEANING AND PROTECTING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than ten (10) days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners

are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

- C. Protect installed tile work with Kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- D. Prohibit foot and wheel traffic from tiled floors for at least seven (7) days after grouting is completed.
- E. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.6 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:

- 1. Tile Installation: TCNA F125A; thin-set mortar on crack isolation membrane.
 - a. Thin-Set Mortar: Latex-Portland cement mortar.
 - b. Grout: Water-cleanable epoxy grout.

END OF SECTION 093000

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

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 acoustical panels and exposed suspension systems for ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which suspension systems will be attached.
 - 3. Size and location of initial access modules for acoustical panels.
 - 4. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- B. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Panels: Full-size panels equal to two percent (2%) of each type of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to two percent (2%) of quantity installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 2. Smoke-Developed Index: 50 or less.
- C. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations:
 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 2. Suspension System: Obtain each type from single source from single manufacturer.

- B. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15¾ inches away from test surface according to ASTM E 795.
- C. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL PANEL 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. Armstrong World Industries, Inc.
 - 2. CertainTeed Corp.
 - 3. Decoustics
 - 4. Frasch!, a Catalyst Acoustics Group company
 - 5. USG Interiors, Inc.; Subsidiary of USG Corporation
 - 6. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.4 ACOUSTICAL PANELS

- A. Basis-of-Design Product (**ACT-1**):
 - 1. Armstrong World Industries, Inc.; **Calla Templok**
 - 2. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - a. Type and Form: Type A, mineral base with acoustically transparent membrane-faced overlay; Form A2.2, water felted; with vinyl overlay on face, back, and sealed edges.
 - b. Pattern: G (smooth).
 - 3. Thickness: 1-inch (border) and 1¼-inch (field).
 - 4. LR, NRC, Color, Edge/Joint Detail, and Modular Size: As indicated in Section 090000 "Schedule of Finishes".
- C. Broad Spectrum Anti-microbial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.5 METAL SUSPENSION SYSTEM

- 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. Armstrong World Industries, Inc.
 2. CertainTeed Corp.
 3. Decoustics
 4. USG Interiors, Inc.; Subsidiary of USG Corporation
 5. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- C. Wide-Face, Double-Web, Hot-Dip Galvanized, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; hot-dip galvanized according to ASTM A 653; with prefinished, cold-rolled, 15/16-inch-wide flanges.
1. Basis-of-Design Product:
 - a. Armstrong World Industries, Inc.; **Prelude XL 15/16-Inch Exposed Tee System**
 2. Structural Classification: Heavy-duty system.
 3. Face Design: Flat, flush.
 4. Finish: Painted white, unless otherwise indicated in Section 090000 "Schedule of Finishes".

2.6 ACCESSORIES

- A. Attachment Devices: Size for five (5) times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
1. Provide manufacturer's standard fasteners and hooks.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at three (3) times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch-diameter wire.
- C. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.
- D. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- E. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

2.7 METAL EDGE MOLDINGS AND TRIM

- 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. Armstrong World Industries, Inc.

2. CertainTeed Corp.
3. USG Interiors, Inc.; Subsidiary of USG Corporation
4. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

- B. Roll-Formed, Sheet-Metal Edge Moldings: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.8 ACOUSTICAL SEALANT

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corporation; **AC-20 FTR Acoustical and Insulation Sealant**
 - b. USG Corporation; **SHEETROCK Acoustical Sealant**
 - c. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

- B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Exposed and Concealed Joints: Non-sag, paintable, non-staining latex sealant.
2. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 - 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three (3) tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 6. Do not attach hangers to roof deck. Attach hangers to structural members.
 - 7. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 - 8. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four (4) tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8-inch in 12 feet. Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
4. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

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

END OF SECTION 095113

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.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

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 for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

- C. Install resilient products after other finishing operations, including painting, have been completed.

1.7 WARRANTY

- A. Provide manufacturer's written limited warranties against defects in materials and against premature wear prior to warranty expiration for the materials as follows:
 - 1. Resilient Base: Two (2) years.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Conform to Class I rating with a flame spread of 0 to 25 in accordance with the requirements of Class A material in accordance with ASTM E 84. Rubber products shall be Class I, 0.45 watts/sq. cm in accordance with ASTM E 648 and NFPA 255.

2.2 THERMOPLASTIC-RUBBER BASE

- A. Basis-of-Design:
 - 1. Johnsonite; A Tarkett Company; **Duracove**
- B. 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. Burke Mercer Flooring Products, Division of Burke Industries Inc.
 - 2. Flexco Corporation
 - 3. Mannington Mills, Inc.
 - 4. Roppe Corporation, USA
 - 5. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- C. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style: B, Cove.
- D. Lengths: Coils in manufacturer's standard length.
- E. Outside and Inside Corners: Pre-formed.
- F. Thickness, Height, and Color: **RB**, as indicated in Section 090000 "Schedule of Finishes".

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less except that adhesive for rubber stair treads shall have a VOC content of 60 g/L or less.

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. Pre-formed Corners: Install pre-formed corners before installing straight pieces.

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.
- 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 096519 - RESILIENT TILE FLOORING

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. Solid vinyl floor tile.
 - 2. Vinyl composition floor tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of floor tile.
 - 1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 2. Show details of special patterns.
- C. Samples: Full-size units of each color and pattern of floor tile required.
- D. Product Schedule: For floor tile. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

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

1.6 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. Floor Tile: Furnish one (1) box for every fifty (50) boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.7 QUALITY ASSURANCE

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

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 SOLID VINYL FLOOR TILE

- A. Basis-of-Design:
 - 1. J&J Flooring Group, LLC; **Into the Woods, Multiple Choices**
- B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AHF Products
 - 2. Armstrong World Industries, Inc
 - 3. Burkert Flooring, a division of Burke Industries
 - 4. Congoleum
 - 5. Mannington Commercial, a business unit of Mannington Mills, Inc.
 - 6. Mohawk Group
 - 7. Patcraft
 - 8. Shaw Industries, Inc.
 - 9. To Market
 - 10. Substitutions: Under provision of Section 012500 "Substitution Procedures".
- C. Tile Standard: ASTM F 1700.

1. Class: Class III, printed film vinyl tile.
2. Type: B, embossed surface.

- D. Thickness, Size, Colors, and Patterns: **LVT**, as indicated in Section 090000 "Schedule of Finishes".

2.3 VINYL COMPOSITION FLOOR TILE

- A. Basis-of-Design:

1. Armstrong World Industries, Inc; **Standard EXCELON Imperial Texture**

- B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Mannington Mills, Inc.
2. Tarkett, Inc.
3. Substitutions: Under provision of Section 012500 "Substitution Procedures".

- C. Tile Standard: ASTM F 1066, Class 1, solid-color tile.

- D. Wearing Surface: Smooth.

1. Slip resistant with a Coefficient of Friction of 0.6 on level surface (dry).

- E. Thickness, Size, Colors, and Patterns: **VCT**, as indicated in Section 090000 "Schedule of Finishes".

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

- C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

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

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 7 or more than 10 pH.
 - 4. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of that indicated in manufacturer's written recommendations.
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum relative humidity level per manufacturer's written recommendations.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate. Expect and include in the Base Bid the requirement to apply and machine level at least three (3) coats of leveler (underlayment) in all spaces.
- D. Do not install floor tiles until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles in pattern of colors and sizes indicated.
 - 2. Lay tiles with grain running in one (1) direction.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other non-permanent marking device.
- G. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

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

END OF SECTION 096519

SECTION 096813 - TILE CARPETING

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

1.3 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include installation recommendations for each type of substrate.
- B. Shop Drawings: For carpet tile installation, plans showing the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Carpet tile type, color, and dye lot.
 - 3. Type of subfloor.
 - 4. Type of installation.
 - 5. Pattern of installation.
 - 6. Pattern type, location, and direction.
 - 7. Pile direction.
 - 8. Type, color, and location of edge, transition, and other accessory strips.
 - 9. Transition details to other flooring materials.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch-long Samples.

D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Carpet Tile: Full-size units equal to five percent (5%) of amount installed for each type indicated, but not less than 10 sq. yd.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.9 DELIVERY, STORAGE, AND HANDLING

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

1.10 FIELD CONDITIONS

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

1.11 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.

2. Failures include, but are not limited to, more than ten percent (10%) edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
3. Warranty Period: Limited lifetime from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE 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. Bentley Mills, Inc.
 2. FLOR
 3. Forbo Flooring Systems
 4. Interface, Inc.
 5. J&J Flooring Group, LLC
 6. Mannington Commercial
 7. Mohawk Group
 8. Patcraft
 9. Shaw Contract Group
 10. StaticSmart Flooring
 11. StaticWorx GroundSafe ESD Flooring
 12. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.2 CARPET TILE

- A. Basis-of-Design Product:
 1. J&J Flooring Group, LLC; **Kinetex**
 2. Material Characteristics: **CPT**, as indicated in Section 090000 "Schedule of Finishes".
 - a. Construction: Textile composite.
 - b. Backing System: Polyester felt cushion.
 3. Performance Characteristics:
 - a. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) according to AATCC 16, Option E.
 - b. Electrostatic Propensity: Less than 3.0 kV according to AATCC 134.
 - c. Slip Resistance: Complies with ADA guidelines for level surface according to ASTM C 1028.

2.3 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, non-staining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes, and depressions 1/8-inch-wide or wider, and protrusions more than 1/32-inch unless more stringent requirements are required by manufacturer's written instructions. Expect and include in the Base Bid the requirement to apply and machine level at least three (3) coats of leveler (underlayment) in all spaces.
- C. Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As indicated in Section 090000 "Schedule of Finishes" and as recommended in writing by carpet tile manufacturer.
- C. Maintain dye lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, non-staining marking device.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Acoustical wall covering.

1.3 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data on physical characteristics, durability, fade resistance and fire-test-response characteristics.
- B. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, seams, and termination points.
- C. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 36-inch-long in size.
 - 1. Wall-Covering Sample: From same production run to be used for the Work, with specified treatments applied. Show complete pattern repeat.
- D. Product Schedule: For wall coverings. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

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

1.7 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. Wall-Covering Materials: For each type, color, texture and finish, full width by length to equal to five percent (5%) of amount installed.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.
- B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.
- C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL WALL COVERING

- A. Basis-of-Design Product:
 - 1. Wolf-Gordon, Inc.; **Felted**
 - 2. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- B. Description: One hundred percent (100%) post-consumer recycled polyester. Provide wall coverings in rolls from same production run.
- C. Test Responses:
 - 1. Colorfastness to Wet and Dry Crocking: Complies with AATCC 8, Grade 4, minimum.
 - 2. Colorfastness to Light: Complies with AATCC 16, Grade 5, minimum, at 40 hours.
 - 3. Acoustical Rating: Complies with ASTM C 243, NRC of 0.20.
- D. Total Weight: Manufacturer's standard.
- E. Width, Colors, Textures, and Patterns: **WC-1**, as indicated in Section 090000 "Schedule of Finishes".

2.3 ACCESSORIES

- A. Adhesive: Mildew-resistant, non-staining, adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.

- B. Primer/Sealer: Mildew resistant, complying with requirements in Section 099123 "Interior Painting" and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.
- C. Seam Tape: As recommended in writing by wall-covering manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation surfaces being true in plane and vertical and horizontal alignment, maximum moisture content, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
 - 1. Moisture Content: Maximum of five percent (5%) on new plaster, concrete and concrete masonry units when tested with an electronic moisture meter.
- D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
- E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 WALL-COVERING INSTALLATION

- A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.
- B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.
- C. Install strips in same order as cut from roll.
- D. Install wall covering without lifted or curling edges and without visible shrinkage.
- E. Trim edges and seams for color uniformity, pattern match and tight closure. Butt seams without overlaps or gaps between strips.
- F. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

3.4 CLEANING

- A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended in writing by wall-covering manufacturer.
- C. Replace strips that cannot be cleaned.
- D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 097200

SECTION 098433 - SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes shop-fabricated panel units tested for acoustical performance, including:
 - 1. Sound-absorbing wall panels.

1.3 DEFINITIONS

- A. NRC: Noise Reduction Coefficient.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include panel edge, core material, and mounting indicated.
- B. Shop Drawings: For unit assembly and installation.
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge and core materials.
 - 3. Include details at cutouts and penetrations for other work.
 - 4. Include elevations showing panel sizes.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Electrical outlets, switches, and thermostats.
 - 2. Items penetrating or covered by sound-absorbing units including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Alarms.
 - e. Sprinklers.
 - f. Access panels.

3. Show operation of hinged and sliding components covered by or adjacent to units.

B. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sound-absorbing units to include in maintenance manuals. Include manufacturers' written cleaning and stain-removal recommendations.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sound-Absorbing Wall Units: Full-size units equal to five percent (5%) of amount installed, but no fewer than five (5) units, minimum of one (1) of each color and size.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 PROJECT CONDITIONS

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

B. Lighting: Do not install sound-absorbing units until a permanent level of lighting is provided on surfaces to receive the units.

C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify locations of sound-absorbing wall units and actual dimensions of openings and penetrations by field measurements before fabrication.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to the following:

- a. Acoustical performance.
- b. Warping of core.

2. Warranty Period: Manufacturer's standard, but minimum of one (1) year from date of Substantial Completion.

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. Acoufelt
 2. Armstrong World Industries, Inc.
 3. Carnegie Fabrics, LLC
 4. CSI Creative
 5. FilzFelt
 6. Kirei USA, LLC
 7. Surface Materials
 8. Wenger Corporation
 9. Wolf Gordon
 10. Zintra, a Baresque group
 11. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.

2.3 SOUND-ABSORBING WALL UNITS

- A. Sound-Absorbing Wall Panel: Manufacturer's standard panel construction consisting of one hundred percent (100%) PET thermally stable plastic with a felt-like finish.
1. Basis-of-Design Product:
 - a. Turf, a member of Armstrong World Industries; **Reed**
 2. Mounting: Direct adhered.
 3. Edge Profile: Square.
 4. Corner Detail in Elevation: Square with continuous edge profile indicated.
 5. NRC, Panel Thickness, Width, Height, and Color: **AWP-2** and **-3**, as indicated in Section 090000 "Schedule of Finishes".
- B. Sound-Absorbing Wall Panel: Manufacturer's standard panel construction consisting of one hundred percent (100%) solution dyed (color through) polyester.
1. Basis-of-Design Product:

a. Acoufelt; **WoodBeQuiet Slats**

2. Mounting: Direct adhered.
3. Edge Profile: Square.
4. NRC, Panel Thickness, Width, Height, and Color: **AWP-1**, as indicated in Section 090000 "Schedule of Finishes".

2.4 MATERIALS

A. Mounting Devices:

1. Manufacturer's standard heavy-duty construction adhesive.

2.5 FABRICATION

- A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to all faces of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
- B. Dimensional Tolerances of Finished Units: Plus or minus 1/16-inch for the following:
1. Thickness.
 2. Edge straightness.
 3. Overall length and width.
 4. Squareness from corner to corner.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fabricated units, substrates, areas, and conditions, for compliance with requirements, installation tolerances, and other conditions affecting unit performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units in locations indicated on Drawings. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
- C. Align and level fabric pattern and grain among adjacent units.

3.3 INSTALLATION TOLERANCES

- A. Variation from Plumb and Level: Plus or minus 1/16-inch.
- B. Variation of Panel Joints from Hairline: Not more than 1/16-inch-wide.

3.4 CLEANING

- A. Clip loose threads; remove pills and extraneous materials.
- B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 098433

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 the following interior substrates:
 - 1. Concrete.
 - 2. Concrete masonry units (CMU).
 - 3. Steel and iron.
 - 4. Galvanized metal.
 - 5. Aluminum (coated).
 - 6. Wood (fiber).
 - 7. Gypsum board.

1.3 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. 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.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

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: Five percent (5%), but not less than 1 gal. of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

- 1. Maintain containers in clean condition, free of foreign materials and residue.
- 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design:
 - 1. Benjamin Moore & Co.
 - 2. Sherwin-Williams Company (The)
- B. 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. ICI Paints
 - 2. PPG Industries, Inc.
 - 3. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of

colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Non-Flat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.
4. Anti-corrosive and Anti-rust Paints Applied to Ferrous Metals: 250 g/L.
5. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
6. Floor Coatings: 100 g/L.

- D. Colors: As selected by Architect and Owner from manufacturer's entire range if not specified as **PT** in Section 090000 "Schedule of Finishes", to match existing where required.

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 coatings 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 (2) 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. Concrete: Twelve percent (12%).
 2. Masonry (Clay and CMUs): Twelve percent (12%).
 3. Gypsum Board: Twelve percent (12%).
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. 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 3, "Power Tool Cleaning."
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- 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: Prime edges, ends, faces, undersides, and backsides of wood.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed in equipment rooms, unless factory-finished:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Pipe hangers and supports.
 - d. Metal conduit.
 - e. Tanks that do not have factory-applied final finishes.
 - f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 2. Paint the following work where exposed in occupied spaces, unless factory-finished:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Pipe hangers and supports.
 - d. Metal conduit.
 - e. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - f. Other items as directed by Architect.
 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

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

3.5 CLEANING AND PROTECTION

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

3.6 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Non-traffic Surfaces:
 - 1. Latex System:
 - a. Prime Coat: Latex, interior, matching topcoat.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, eggshell (Gloss Level 3), **MPI #52.**
- B. CMU Substrates:
 - 1. Latex System:
 - a. Block Filler: Block filler, latex, interior/exterior, **MPI #4.**
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, eggshell, (Gloss Level 3), **MPI #52.**
- C. Steel Substrates:
 - 1. Latex System, Alkyd Primer:
 - a. Prime Coat: Primer, alkyd, quick dry, for metal, **MPI #76.**
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, flat (Gloss Level 1), **MPI #53.**
 - d. Topcoat: Latex, interior, semi-gloss (Gloss Level 5), **MPI #54.**
- D. Galvanized-Metal Substrates:
 - 1. Latex System:
 - a. Prime Coat: Primer, galvanized, water based, **MPI #134.**
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, semi-gloss (Gloss Level 5), **MPI #54.**
- E. Aluminum (Coated) Substrates:
 - 1. Latex System:
 - a. Prime Coat: Primer, quick dry, for aluminum, **MPI #95.**

- b. Intermediate Coat: Latex, interior, matching topcoat.
- c. Topcoat: Latex, interior, semi-gloss (Gloss Level 5), **MPI #54.**

F. Wood (Fiber) Substrates:

1. Latex over Latex Primer System:

- a. Prime Coat: Primer, latex, for interior wood, **MPI #39.**
- b. Intermediate Coat: Latex, interior, matching topcoat.
- c. Topcoat: Latex, interior, eggshell (Gloss Level 3), **MPI #52.**

G. Gypsum Board/Plaster Substrates:

1. Latex System:

- a. Prime Coat: Primer sealer, latex, interior, **MPI #50.**
- b. Intermediate Coat: Latex, interior, matching topcoat.
- c. Topcoat: Latex, interior, flat, (Gloss Level 1), **MPI #53.**
- d. Topcoat: Latex, interior, eggshell, (Gloss Level 3), **MPI #52.**

END OF SECTION 099123

SECTION 099300 - STAINING AND TRANSPARENT FINISHING

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 application of wood finishes.

1.3 DEFINITIONS

- A. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified in Part 2, with the product proposed for use highlighted.
 - 2. Indicate VOC content.
- B. Samples: For each type of finish system and in each color and gloss of finish indicated.
 - 1. Submit Samples on representative samples of actual wood substrates, 8 inches long.
 - 2. Label each Sample for location and application area.
- C. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules.

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. Stains and Transparent Finishes: Five percent (5%), but not less than 1 gallon of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

- A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply finishes when relative humidity exceeds eighty-five percent (85%); at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior finishes in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Benjamin Moore & Co.
 - 2. Cabot
 - 3. Pratt & Lambert
 - 4. Sherwin-Williams Company (The)
 - 5. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.2 MATERIALS, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior stains and finishes applied at project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 1. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 - 2. Shellacs, Clear: VOC not more than 730 g/L.

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 Interior Wood Substrates: Fifteen percent (15%), when measured with an electronic moisture meter.

- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with finish application only after unsatisfactory conditions have been corrected.
 - 1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
 - 1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
 - 2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.
- D. Interior Wood Substrates:
 - 1. Refer to AWI recommendations.
 - 2. Scrape and clean knots and apply coat of knot sealer.
 - 3. Sand surfaces that will be exposed to view and dust off.

3.3 APPLICATION

- A. Apply finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for finish and substrate indicated.
 - 2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
 - 3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

- B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from finish application. Correct damage 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 finished wood surfaces.

3.5 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. Wood Substrates, Non-Traffic Surfaces.

1. Polyurethane Varnish System:

- a. Prime Coat: Polyurethane varnish matching topcoat.
- b. Intermediate Coat: Polyurethane varnish matching topcoat.
- c. Topcoat: Varnish, interior, polyurethane, oil modified, satin (Gloss Level 4), **MPI #57**.

END OF SECTION 099300

SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Markerboards.
 - 2. Tack surfaces.

- B. Related Requirements:

- 1. Section 101146 "Visual Display Fabrics" for visual display wall coverings intended for use with dry-erase markers.

1.3 DEFINITIONS

- A. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes chalkboards, markerboards, and tackboards.
- B. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of chalkboards, markerboards, tackboards, and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

1.4 ACTION SUBMITTALS

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

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.

- B. Shop Drawings: For visual display units.

- 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Show locations of panel joints.
 - 3. Include sections of typical trim members.

- C. Samples: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:

- 1. Actual sections of porcelain-enamel face sheet and tackboard assembly surface.
 - 2. Include accessory Samples to verify color selected.

- D. Product Schedule: For visual display units. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.
- B. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For visual display units to include in maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-fabricated visual display units completely assembled in one (1) piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one (1) piece, provide two (2) or more pieces with joints in locations indicated on approved Shop Drawings.
- B. Store visual display surfaces vertically with packing materials between each unit.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces exhibit crazing, cracking, or flaking.
 - 2. Warranty Period: Life of the building.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of visual display unit from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.

2.3 MARKERBOARD ASSEMBLIES

- A. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of moisture-barrier backing, core material, and 0.021-inch-thick, porcelain-enamel face sheet with high or low-gloss finish.
 - 1. Basis-of-Design:
 - a. Claridge Products and Equipment, Inc.; **LCS Deluxe Series 3**
 - 2. 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. AARCO Products, Inc.
 - b. ADP Lemco, Inc.
 - c. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
 - 3. MDF Core: 7/16-inch-thick; with manufacturer's standard moisture-barrier backing.
 - 4. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.

2.4 MARKERBOARD AND TACKBOARD ACCESSORIES

- A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch-thick, extruded aluminum; of size and shape indicated on Drawings.
 - 1. Factory-Applied Trim: Manufacturer's standard.
- B. Chalktray: Manufacturer's standard, continuous.
 - 1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.

2.5 TACK SURFACES

- A. Natural-Cork Tackboard Surface: ¼-inch-thick cork.
 - 1. Basis-of-Design:
 - a. Wolf-Gordon, Inc.; **Bulletin Board Cork Colored**
 - b. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2.6 MATERIALS, GENERAL

- A. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
- B. Natural-Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish; with surface-burning characteristics indicated, on a jute backing.
- C. MDF: ANSI A208.2, Grade 130.
- D. Extruded Aluminum: ASTM B 221, Alloy 6063.

2.7 FABRICATION

- A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
- B. Visual Display Boards: Factory assemble visual display boards unless otherwise indicated.
 - 1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.
- C. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.
 - 1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
 - 2. Provide manufacturer's standard vertical-joint spline system between abutting sections of markerboards.
 - 3. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.
- D. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
 - 1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010-mm or thicker.

2.10 VISUAL DISPLAY SCHEDULE

- A. Visual Display Board: Factory assembled.
 - 1. Markerboard: Porcelain-enamel markerboard assembly.
 - a. Color: **WB**, as indicated in Section 090000 "Schedule of Finishes".
 - 2. Corners: Square.

3. Size and Mounting Height: As indicated on Drawings.
4. Mounting: Wall.
5. Factory-Applied Aluminum Trim: Manufacturer's standard with clear anodic finish.
6. Accessories:

- a. Chalktray: Box type.

B. Visual Display Surface:

1. Tack Board: Natural cork.
 - a. Color: **TB**, as indicated in Section 090000 "Schedule of Finishes".
2. Corners: Square.
3. Size and Mounting Height: As indicated on Drawings.
4. Mounting: Wall.
5. Edges: Concealed by trim where indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine walls and partitions for proper preparation and backing for visual display surfaces.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.

3.3 INSTALLATION

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Factory-Fabricated Visual Display Board Assemblies: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.

3.4 CLEANING AND PROTECTION

- A. Clean visual display units in accordance with manufacturer's written instructions. Attach one (1) removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 101100

SECTION 101146 - VISUAL DISPLAY FABRICS

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 dry-erase wall coverings.
- B. Related Requirements:
 - 1. Section 101100 "Visual Display Units" for manufactured visual display units, including markerboards.

1.3 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of dry-erase wall covering. Include data on physical characteristics, durability, and flame-resistance characteristics.
- B. Shop Drawings: Show location and extent. Indicate seams and termination points.
- C. Samples: Full width by 36-inch-long section of dry-erase wall covering.
- D. Product Schedule: For dry-erase wall coverings. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For surface-burning characteristics of each type of dry-erase wall covering, for tests performed by a qualified testing agency.
- B. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For dry-erase wall coverings to include in maintenance manuals.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install dry-erase wall coverings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace visual display fabric that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Cracking, chipping, or peeling.
 - b. Permanent staining, yellowing, or fading when used with appropriate dry erase markers.
 - 2. Warranty Period: Ten (10) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 55 or less.
 - 2. Smoke-Developed Index: 90 or less.

2.2 DRY-ERASE WALL COVERINGS

- A. Magnetic Dry-Erase Wall Covering (**WC-2**): Intended for use with dry-erase markers and magnetic aids and consisting of high-gloss plastic film bonded to ferrous-powdered fabric backing.
 - 1. Basis-of-Design:
 - a. Wolf-Gordon, Inc.; **Wink Magnetic**
 - 2. 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. Koroseal Interior Products, LLC
 - b. Write Walls
 - c. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
 - 3. Color: White.
- B. Adhesives for Field Application: Strippable, mildew-resistant, non-staining adhesive for use with dry-erase wall coverings and for substrate application as recommended in writing by dry-erase wall covering manufacturer.
- C. Primer/Sealer: Mildew-resistant primer/sealer as recommended in writing by dry-erase wall covering manufacturer for intended substrate.
- D. Frames and Trim: ASTM B 221, Alloy 6063 extruded aluminum, fabricated in straight, single length, keeping joints to a minimum. Miter corners to a neat, hairline closure.
 - 1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010-mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, moisture content, and other conditions affecting performance of the Work.
- B. Examine walls and partitions for proper preparation for dry-erase wall covering.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, including dirt, mold, and mildew, that could impair the bond of dry-erase wall coverings or affect the smooth, finished surfaces of dry-erase wall coverings.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, and depressions.
- D. Prepare substrates indicated to receive dry-erase wall covering as required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.
 - 1. Moisture Content: Maximum of four percent (4%) when tested with an electronic moisture meter.
 - 2. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.

3.3 INSTALLATION

- A. Dry-Erase Wall Covering: Comply with dry-erase wall-covering manufacturers' written installation instructions.
 - 1. Install seams horizontal and level, with lowest seam 24 inches above finished floor. Railroad fabric (reverse roll direction) to ensure color matching.
 - 2. Double cut seams, with no gaps or overlaps. Remove air bubbles, wrinkles, blisters, and other defects.
 - 3. After installation, clean dry-erase wall covering in accordance with manufacturer's written instructions. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

3.4 CLEANING AND PROTECTION

- A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
- B. Clean dry-erase wall covering in accordance with manufacturer's written instructions. Attach one removable cleaning instructions label to dry-erase wall covering in each room.
- C. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 101146

SECTION 101400 - SIGNAGE

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. Panel signs.
- B. Related Sections include the following:
 - 1. Section 015000 "Temporary Facilities and Controls" for temporary information and directional signs.
 - 2. Section 220553 "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
 - 3. Section 230553 "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
 - 4. Section 260553 "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
 - 5. Section 265119 "LED Interior Lighting" for illuminated Exit signs.
 - 6. Section 265219 "Emergency and Exit Lighting" for illuminated Exit signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For panel signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign.
- C. Samples: Manufacturer's color charts consisting of actual units or sections of units showing the full range of colors available for the following:
 - 1. Acrylic Sheet: Full-size Sample for each color required.
- D. Sign Schedule: Use same designations indicated on Drawings or as listed in special schedule.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image
 - c. Separation or delamination of sheet material and components.
 - 2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction and ICC/ANSI A117.1.
- B. Source Limitations for Signs: Obtain each sign type indicated from one (1) source from a single manufacturer.

2.2 PANEL SIGNS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. ASE, Inc.
 - 2. Best Sign Systems, Inc.
 - 3. Intelligent Signage, Inc.
 - 4. Seton Identification Products
 - 5. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- B. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16-inch measured diagonally from corner to corner.
- C. Interior Signs: Provide matte finish plaques in sizes to accommodate the message indicated in the Signage Schedule on the Door Schedule and the Signage Details drawing in the Construction Documents. Fabricate of thermoformed acrylic plastic conforming to ASTM D 709, Type NDP minimum 1/8-inch. Provide with square corners.
 - 1. Graphics Application:

- a. Raised Letters: Minimum 1/32-inch-thick acrylic message letters. These shall comply with Section 703.2.3 (not italic, oblique, script or decorative) and 703.2.5 (1-inch character height) of the ICC/ANSI A117.1 Code.
- b. Pictogram: Each sign shall be provided with an international symbol of accessibility per Section 4.30.7 (Figure 43 a and b) of the Americans with Disabilities Act. The raised image pictogram shall have a field height of 6 inches minimum. Text and braille shall NOT be located in the pictogram field.
- c. Messages:
 - 1) Typeface: Helvetica Medium, with accompanying Grade 2 Braille message.
 - 2) Type Size: 1-inch large and small case, with width, height and stroke complying with the requirements of Section 703.2.6 (maximum stroke width fifteen percent (15%) of the height of each letter at the top surface of the character and thirty percent (30%) maximum of the height of each letter at the base, Section 703.2.7 (character spacing 1/8-inch minimum and four (4) times the tactile character stroke width maximum), and Section 703.2.8 (spacing between lines shall be between one hundred thirty-five percent (135%) and one hundred seventy percent (170%) of the tactile character height) of the ICC/ANSI A117.1 Code.
 - 3) Background Color: In color selected by Architect and Owner from manufacturer's entire range. Message Color: In contrasting color of background.

2.3 MATERIALS

- A. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).

2.4 ACCESSORIES

- A. Adhesive: As recommended by sign manufacturer.
 - 1. Adhesive shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FABRICATION

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

2.6 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five (5) years for application intended.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Accessible Signage: Install in locations on walls as indicated on Drawings and according to the accessibility standard.
 - 1. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.
- C. Mounting Methods:
 - 1. Silicone-Adhesive Mounting: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101400

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

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. Cast dimensional characters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
- C. Samples: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Dimensional Characters: Full-size Sample of each type of dimensional character.
 - 2. Exposed Accessories: Full-size Sample of each accessory type.
- D. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer of products.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 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. Alphabet Signs, Inc.
 - 2. ASI Sign Systems, Inc.
 - 3. Gemini Incorporated
 - 4. Impact Signs, Inc.
 - 5. PHOTOMETALS, a division of PMA Industries
 - 6. Seton Identification Products
 - 7. Woodland Manufacturing, LLC
 - 8. Substitution Procedures: Under provisions of Section 012500 "Substitution Procedures".

2.3 DIMENSIONAL CHARACTERS

- A. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
 - 1. Character Material: Cast aluminum.
 - 2. Character Height: As indicated on Drawings.
 - 3. Thickness: Manufacturer's standard for size of character, but not larger than ½-inch.
 - 4. Finishes:
 - a. Baked-Enamel or Powder-Coat Finish: **MS-1**, as indicated in Section 090000 "Schedule of Finishes".
 - 5. Mounting: Projecting studs.
 - 6. Typeface: As indicated on Drawings.

2.4 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B 26, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.
- B. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.5 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, non-corrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. Sign Mounting Fasteners:
 - a. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.

2.6 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Pre-assemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
 - 7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

2.7 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
 - 1. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101419

SECTION 105613 - METAL STORAGE SHELVING

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. Post-and-beam (wide span) metal storage shelving.

1.3 COORDINATION

- A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to wall and ceiling assemblies.
- B. Coordinate locations and installation of metal storage shelving that may interfere with ceiling systems including lighting, HVAC, speakers, sprinklers, access panels, electrical switches or outlets, and floor drains.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.
- B. Shop Drawings: For metal storage shelving.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include installation details of connectors, lateral bracing, and special bracing.
- C. Samples: For each type of metal storage shelving and for each color specified, in the following sizes:
 - 1. Vertical Supports: 12 inches tall.
 - 2. Shelves: Full size, but not more than 24 inches wide by 12 inches deep.
 - 3. Connectors: Full size.
- D. Product Schedule: For metal storage shelving. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Seismic Qualification Certificates: For metal storage shelving, accessories, and components, from manufacturer.
- C. Product Certificates: For each type of metal storage shelving.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Shelves: Full-size units equal to five percent (5%) of amount installed for each type indicated, but no fewer than five (5) shelves.
 - 2. Shelf-to-Post Connectors: Full-size units equal to five percent (5%) of amount installed for each type indicated, but no fewer than ten (10) connectors.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating storage shelving that meets or exceeds performance requirements indicated and of documenting this performance by test reports, and calculations.
- B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for building occupants during the remainder of the construction period.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of metals, metal finishes, and other materials beyond normal wear.
 - 2. Warranty Period: Limited lifetime for the original purchaser.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Metal storage shelving shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Seismic Component Importance Factor: 1.0.

2.2 POST-AND-BEAM METAL STORAGE SHELVING

- A. Post-and-Beam Metal Shelving: Complying with MH 28.2; field-assembled from factory-formed components. Shelves are supported by beams that span between supporting corner posts that

allow beam-height adjustment over full height of shelving unit. Provide fixed top and bottom beams, adjustable intermediate beams, and accessories indicated.

1. Basis-of-Design:

- a. Spacesaver Corporation; **RaptorRAC Wide Span Shelving**
- b. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

B. Load-Carrying Capacity per Shelf: 1000 lb.

C. Posts: Fabricated from cold-rolled steel; in open-box shape; with perforations at 1½ inches o.c. to receive beam-to-post connectors.

1. Unit Configuration: Configure shelving units as individual, freestanding assemblies.
2. Steel Thickness, Nominal: 14-gauge, minimum, but as required for load-carrying capacity per shelf and number of shelves.
3. Post Base: Cold-rolled steel floor plate, drilled for floor anchors.
4. Braces: Cold-rolled steel, nominal 14-gauge minimum thickness, tube or open channel.

D. Beams: Fabricated from cold-rolled steel; in manufacturer's standard shape. Provide beam at each side of each shelf, with center supports as required for load-carrying capacity of shelf.

1. Steel Thickness, Nominal: 12-gauge, minimum, but as required for load-carrying capacity per shelf.
2. Beam-to-Post Connectors: Projecting manufacturer's standard at each end that engage posts.
3. Beam Quantity: As required for number of shelves indicated per shelving unit.

E. Particleboard Shelves: 11/16-inch-thick; factory or field cut.

F. Overall Unit Width, Depth, and Height: As indicated on Drawings.

G. Accessories:

1. Tie Plates: Cold-rolled steel, finished to match posts; designed for joining posts of adjacent shelving units.
2. Supports: Back-to-wall type that bolt to posts; as required for shelving unit stability.

H. Steel Finish: Baked enamel or powder coat.

1. Color and Gloss: As selected by Architect and Owner from manufacturer's entire range.

2.3 ANCHORS

A. Floor Anchors: Galvanized-steel, post-installed expansion anchors, power-actuated fasteners, or threaded concrete screws. Provide number per unit recommended by manufacturer unless additional anchors are indicated in calculations.

B. Wall Anchors: Manufacturer's standard, galvanized-steel anchors designed to secure metal storage shelving to adjacent wall. Provide one (1) per shelving unit for each shelving unit adjacent to a wall unless additional anchors are recommended by manufacturer.

2.4 FABRICATION

- A. Fabricate metal storage shelving components to provide field-assembled units that are square and rigid, with posts plumb and true and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.
 - 1. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
 - 2. Build in straps, plates, brackets, and other reinforcements as needed to support shelf loading.
 - 3. Cut, reinforce, drill, and tap metal fabrications to receive hardware, fasteners, and similar items.
- B. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
- C. Form edges and corners free of sharp edges or rough areas. Fold back and crimp exposed edges of unsupported sheet metal to form a hem on the concealed side; ease edges of metal plate to radius of approximately 1/32-inch. Shear and punch metals cleanly and accurately. Remove burrs.
- D. Weld corners and seams continuously to develop strength, minimize distortion, and maintain the corrosion resistance of base metals. At exposed locations, finish welds and surfaces smooth and blended so surface is smooth after finishing and contour of welded surface matches that of adjacent surface. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces before finishing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine floors for suitable conditions where metal storage shelving will be installed.
- C. Examine walls to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Vacuum and clean finished floor over which metal storage shelving is to be installed.

3.3 INSTALLATION

- A. Install metal storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.
 - 1. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 2. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
 - 3. Adjust post-base bolt leveler to achieve level and plumb installation.

4. Anchor shelving units to floor with floor anchors through floor plate. Shim floor plate to achieve level and plumb installation.
5. Install seismic restraints.
6. Connect side-to-side shelving units together.
7. Install shelves in each shelving unit at equal spacing.
 - a. Post-and-Beam Metal Storage Shelving: Install beams with beam-to-post connectors fully engaged in post perforations.

3.4 ERECTION TOLERANCES

- A. Erect post-and-beam metal storage shelving to a maximum tolerance from vertical of ¼-inch in 84 inches of height.

3.5 ADJUSTING

- A. Adjust metal storage shelving so that connectors and other components engage accurately and securely.
- B. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.
- C. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.
- D. Replace metal storage shelving components that have been damaged beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 105613

SECTION 122413 - ROLLER WINDOW SHADES

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. Manually operated roller shades with single rollers.
 - 2. Motor-operated roller shades with single rollers.

- B. Related Requirements:

- 1. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.

1.3 ACTION SUBMITTALS

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

- 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

- 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

- C. Samples: For each exposed product and for each color and texture specified, 10 inches long.

- D. Product Schedule: For roller shades. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Product Certificates: For each type of shadeband material.

- C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Roller Shades: Full-size units equal to five percent (5%) of quantity installed for each size, color, and shadeband material indicated, but no fewer than two (2) units.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product:
 - 1. Rollease Acmeda; **Contract Series**
- B. 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. Draper, Inc.
 - 2. Hunter Douglas
 - 3. MechoShade Systems, Inc.
 - 4. OEM Shades Inc.
 - 5. SWF Contract
 - 6. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
- C. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: Stainless-steel.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Chain tensioner, sill mounted.
 2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller-shade weight and lifting heavy roller shades.
 - a. Provide for shadebands that weigh more than 10 lb. or for shades as recommended by manufacturer, whichever criteria are more stringent.
 - B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 1. Roller Drive-End Location: Right side of inside face of shade.
 2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
 - C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
 - D. Shadebands:
 1. Shadeband Material: Light-filtering fabric.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
- 2.3 MOTOR-OPERATED, SINGLE-ROLLER SHADES
- A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
 1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Electric Motor: Manufacturer's standard tubular, enclosed in roller.
 - a. Electrical Characteristics: Single phase, 120 V, 60 Hz.
 3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
 - b. Individual/Group Control Station: Maintained -contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
 - c. Color: As selected by Architect and Owner from manufacturer's entire range.

4. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
5. Operating Features:
 - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 1. Roller Drive-End Location: Right side of inside face of shade.
 2. Direction of Shadeband Roll: Regular, from back of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three (3) inline rollers that are operated by one (1) roller drive-end assembly.
- E. Shadebands:
 1. Shadeband Material: Light-filtering fabric.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
- F. Installation Accessories:
 1. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard in height required to enclose roller and shadeband when shade is fully open, but not less than 4 inches.
 2. Endcap Covers: To cover exposed endcaps.
 3. Installation Accessories Color and Finish: As selected from manufacturer's entire range.

2.4 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 1. Basis-of-Design Product: **Ambient Renew Series**
 2. Source: Roller-shade manufacturer.
 3. Type: Recycled and virgin polyester, PVC-free.
 4. Weave: Basketweave.
 5. Roll Width: Per manufacturer.
 6. Orientation on Shadeband: Up the bolt.
 7. Openness Factor and Color: **WS**, as indicated in Section 090000 "Schedule of Finishes".

2.5 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less ¼-inch per side or ½-inch total, plus or minus 1/8-inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less ¼-inch, plus or minus 1/8-inch.
 - 2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
 - 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Roller Shade Locations: As indicated on Drawings.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.

- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 122413

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

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. Solid surface material countertops.
 - 2. Solid surface material backsplashes.

1.3 ACTION SUBMITTALS

- A. Product Data: For solid surfacing materials.
- B. Shop Drawings: Show materials, finishes, edge and backsplash profiles, and methods of joining.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any.
- C. Samples: For the following products:
 - 1. Solid surfacing material, 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface materials to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

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

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements before fabrication is complete.

1.8 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
 - 1. Basis-of-Design Product:
 - a. E. I. du Pont de Nemours and Company; **Corian Solid Surface**
 - 2. 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. Avonite Surfaces by Aristech Surfaces LLC
 - b. Formica Corporation
 - c. LG Chemical, Ltd.
 - d. Wilsonart International
 - e. Substitutions: Under provisions of Section 012500 "Substitution Procedures".
 - 3. Type: Provide Standard type unless Special Purpose type is indicated.
 - 4. Colors and Patterns: **SS**, as indicated in Section 090000 "Schedule of Finishes".
- B. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made for wet environments.

2.2 FABRICATION

- A. Fabricate according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: **Custom**.
- B. Configuration:
 - 1. Front: As indicated on Drawings.
 - 2. Backsplash: Straight, slightly eased at corner.
- C. Countertops: ½-inch-thick, solid surface material with front edge built up with same material.
- D. Splashes: ½-inch-thick, solid surface material.
- E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose back splashes for field assembly.
- F. Joints: Fabricate countertops without joints.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
 - 1. Adhesives shall not contain urea formaldehyde.
- B. Sealant: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material and conditions under which material will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8-inch in 8 feet, 1/4-inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten subtops to base units by screwing through subtops into cornerblocks of base units. Shim as needed to align subtops in a level plane.
- C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- D. Install splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- E. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
 - 1. Seal edges of cutouts in subtops by saturating with varnish.
- F. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 210100 - GENERAL CONDITIONS FOR FIRE PROTECTION TRADE

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. General Conditions, Supplementary Conditions, and Division 01 paragraphs may be repeated in this Division for emphasis or for inclusion of more stringent/additional related requirements. Such repetition shall not be construed to reduce the requirements of those Divisions nor to eliminate other requirements under those Divisions.

1.2 DESCRIPTION

- A. The General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions shall be assumed to be omitted if not repeated therein.
- C. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of Division 21.
- D. The following information contains specifications of Work in connection with, and in addition to, this Division:
 - 1. All drawings associated with the project.
 - 2. All specifications associated with the project.
- E. Divisions of work responsibilities shall be defined and directed by the General Contractor or Construction Manager.

1.3 INTENT

- A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.
- B. Furnish, deliver, and install any apparatus, appliance, material, or work not shown on Drawings but mentioned in the Specifications, or vice versa, or any incidental accessories necessary to make the Work complete and perfect in all respects and ready for operation, even if not particularly specified, under their respective Section without additional expense to the Owner.
- C. Include in the work minor details not usually shown or specified but necessary for proper installation and operation, as though they were hereinafter shown or specified.
- D. Provide Engineer written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules, or regulations of authorities having jurisdiction; and any necessary items of Work omitted. In the absence of such written notice, it is mutually agreed that Work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

- E. The Work indicated is diagrammatic. The Architect and/or Engineer may require as part of this Contract, the relocation of devices to reasonable distances from the general locations shown.
- F. Verbal clarifications of the Drawings or Specifications during the bid period are not to be relied upon. Refer any questions or clarifications to the Engineer as indicated in the Division 00 documents.

1.4 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. (Do not scale the Drawings.) Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect.
- B. Closely follow Drawings in layout of Work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom. Where space conditions appear inadequate, Engineer shall be notified before proceeding with installations.
- C. Engineer may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, include the item or arrangement of better quality, greater quantity, or higher cost in the Contract price. The Engineer shall decide on the item and the manner in which the work shall be installed.

1.5 SURVEYS AND MEASUREMENTS

- A. Before submitting a Bid, the Contractor shall visit the site and shall become thoroughly familiar with all conditions under which the work will be installed. Contractor will be held responsible for any assumptions, omissions, or errors made as a result of failure to become familiar with the site and the Contract Documents.
- B. Base all measurements, both horizontal and vertical, from established benchmarks. All Work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the Work.
- C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or the intent of the Drawings and Specifications, notify the Engineer and do not proceed with that Work until instructions have been received from the Engineer.

1.6 CODES AND STANDARDS

- A. The Codes and Standards listed below apply to all Work. Where Codes or Standards are mentioned in these Specifications, follow the latest edition or revision.
- B. The current adopted editions of the following State or local Codes apply:

2022 State of Connecticut Building Code/2021 IBC with CT Amendments
2022 State of Connecticut fire Safety Code/2021 IFC with CT Amendments
2022 International Existing Building Code (including CT Amendments)
2022 International Mechanical Code (including CT Amendments)
2022 International Plumbing Code (including CT Amendments)
2022 International Energy Conservation Code (including CT Amendments)

2022 National Electric Code (NFPA 70/2020 CT Amendments)
2017 ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities
2015 International Plumbing Code and referenced publications
NFPA 54/2021, National Fuel Gas Code
NFPA 72/2019, National Fire Alarm Code
AWWA Standards
Factory Mutual Approval Guide: latest edition
Pipe Hangers and Supports: MSS SP-58
UL Compliance
Local Building Code

C. The following Standards shall be used where referenced by the following abbreviations:

AABC Associated Air Balance Council
ACGIH American Conference of Governmental Industrial Hygienists
ADC Air Diffusion Council
AGA American Gas Association
AIA American Institute of Architects
AMCA Air Moving and Conditioning Association
ANSI American National Standards Institute
API American Petroleum Institute
ARI Air Conditioning and Refrigeration Institute
ASE Association of Safety Engineers
ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME American Society of Mechanical Engineers
ASPE American Society of Plumbing Engineers
ASTM American Society of Testing and Materials
AWS American Welding Society
AWWA American Water Works Association
CGA Compressed Gas Association
CSA Canadian Standards Association
CISPI Cast Iron Soil Pipe Institute
EJMA Expansion Joint Manufacturing Association
EPA Environmental Protection Agency
FM Factory Mutual Insurance Association
FSSC Federal Specification
HIS Hydraulic Institute Standards
IBR Institute of Boiler and Radiator Manufacturers
IEEE Institute of Electrical and Electronics Engineers
IRI Industrial Risk Insurers
ISO Insurance Services Office
MCAA Mechanical Contractors Association of America
MSS Manufacturers Standardization Society
NBS National Bureau of Standards
NEBB National Environmental Balancing Bureau
NEMA National Electrical Manufacturers Association
NFPA National Fire Protection Association
NOFI National Oil Fuel Institute
NRC National Research Council
NSC National Safety Council
NSF National Sanitation Foundation
OSHA Occupational Safety and Health Administration
PDI Plumbing and Drainage Institute
SAMA Scientific Apparatus Manufacturers Association
SBI Steel Boiler Industry (Division of Hydronics Institute)
SMACNA Sheet Metal and Air Conditioning Contractors National Association

STI Steel Tank Institute
UL Underwriters' Laboratories

- D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction, and the requirements of all Governmental departments having jurisdiction.
- E. Include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus, and Drawings in order to comply with all applicable laws, ordinances, rules, and regulations, whether or not shown on Drawings and/or specified.

1.7 PERMITS AND FEES

- A. Give all necessary notices, obtain all permits, and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Work. File all necessary Drawings, prepare all Documents, obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspections for Work, and deliver a copy to the Engineer before request for acceptance and final payment for the Work.

1.8 SEISMIC RESTRAINT

- A. General: This project is in a seismic zone per State and/or Local Codes and Ordinances and all materials and equipment shall be installed, supported, and seismically restrained accordingly. Verify current seismic requirements based on project location and with Code requirements.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those required for this Project in material, design, and extent.
- C. Shop Drawings: Show designs and calculations, certified by a professional engineer, for the following:
 - 1. Design Calculations: Calculations for selection of vibration isolators, design of vibration isolation bases, design of seismic supports, and selection of seismic restraints for all equipment and materials.
 - 2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.
 - 3. Seismic Restraint Details: Detail fabrication and attachment of restraints, supports, and snubbers.
- D. Installation: Installation shall be carried out in strict accordance with the Seismic Engineer's submittal, current Code, accepted standards, and the equipment and material manufacturers' recommendations.

1.9 COORDINATION

- A. Carry out all work in conjunction with other trades and give full cooperation in order that all Work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the General

Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, access doors, etc. required by other trades.

- B. Contractors are required to examine all the Project Drawings and mutually arrange Work so as to avoid interference. In general, ductwork, heating piping, sprinkler piping, and drainage lines take precedence over water, gas, and electrical conduits. The Engineer regarding the arrangement of Work, which cannot be agreed upon by the Contractors, will make final decisions.
- C. Where the Work of the Contractor will be installed in close proximity to or will interfere with Work of other trades, assist in working out space conditions to make a satisfactory adjustment.
- D. If Work is installed before coordinating with other Divisions or so as to cause interference with Work of other Sections, the Contractor causing the interference will make necessary changes to correct the condition without extra charge to the Owner.
- E. Initial contact and coordination has been conducted with utility entities for the purpose of the preparation of Bid Documents. The Contractor shall coordinate all final specific utility requirements.

1.10 ACCEPTANCES

- A. The equipment, materials, workmanship, design, and arrangement of all Work installed are subject to the review of the Engineer.
- B. Within thirty (30) days after the awarding of a Contract, submit to the Engineer for review a list of manufacturers of equipment proposed for the Work. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.
 - 1. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, notify the Engineer, in writing, within thirty (30) days of the awarding of the Contract. In such instances, deviations may be made pending acceptance by the Engineer or the Owner's representative.
- C. Where any specific material, process, or method of construction or manufactured article is specified by reference to the catalog or model number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- D. If material or equipment is installed before shop drawing review, liability for its removal and replacement is assumed by the Contractor, at no extra charge to the Owner, if, in the opinion of the Engineer, the material or equipment does not meet the intent of the Drawings and Specifications.
- E. Failure on the part of the Engineer to reject shop drawings or to reject Work in progress shall not be interpreted as acceptance of Work not in conformance with the Drawings and/or Specifications. Correct Work not in conformance with the Drawings and/or Specifications whenever non-conformance is discovered.

1.11 EQUIPMENT DEVIATIONS

- A. Refer to Section 016000 "Product Requirements". Where the Contractor proposes to deviate (substitute or provide an equivalent) from the equipment or materials as hereinafter specified, he shall do so by making a request in writing. The Contractor shall state in his request whether it is a substitution or an equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer's equipment cuts. The Base Bid shall be based on using the materials and equipment as specified and scheduled with no exceptions. Equipment manufacturers scheduled on Drawings are considered Base Bid and any other acceptable manufacturers listed in the specifications is considered a substitution and equipment deviation and subject to the requirements for equipment substitution and deviation. When any alternate manufacturer does not qualify acceptable, as determined by the Engineer, provide the Base Bid manufacturer at no additional cost to Owner.
- B. In these Specifications and on the accompanying Drawings, one (1) or more makes of materials, apparatus, or appliances may have been specified for use in this installation. This has been done for convenience in fixing the standard of workmanship, finish, and design required for installation. In the event that only one (1) manufacturer of a product is specified, and it is found that the manufacturer has discontinued the product, the Contractor shall use an acceptable equivalent product that meets the requirements of an equivalent product, as noted below, and has all the features of the originally specified product. The details of workmanship, finish, and design, and the guaranteed performance of any material, apparatus, or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.
- C. Where no specific make of material, apparatus, or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineer's review.
- D. Where two (2) or more names are given as equivalents, the Contractor must use the specified item or one (1) of the named equivalents. Where one (1) name only is used and is followed by the words "or acceptable equivalent", the Contractor must use the item named or he may apply for an equipment deviation through the prescribed manner in accordance with this Specification.
- E. Equipment, material, or devices submitted for review as an "accepted equivalent" shall meet the following requirements:
 - 1. The equivalent shall have the same construction features such as, but not limited to:
 - a. Material thickness, gauge, weight, density, etc.
 - b. Welded, riveted, bolted, etc., construction.
 - c. Finish, undercoatings, corrosion protection.
 - 2. The equivalent shall perform with the same or better operating efficiency.
 - 3. The equivalent shall have equal or greater reserve capacity.
 - 4. The equivalent shall be locally represented by the manufacturer for service, parts, and technical information.
 - 5. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as AMCA or ARI labels.
- F. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Designers of Record at the expense of the Contractor and at no additional cost to the Owner.

- G. Where such accepted deviation or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit, and equipment from that specified or indicated on the Drawings, the Contractor shall, with the acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the substitution.
- H. The Engineer shall determine if an "accepted equivalent" to a manufacturer listed in the Specifications is considered acceptable.

1.12 SHOP DRAWINGS

- A. Refer to individual specification sections for additional submittal information.
- B. Submitted shop drawings of fire sprinkler system(s) and/or fire standpipe system(s) shall be sealed and signed by an Engineer registered to practice engineering in the State of Connecticut or licensed Layout Technician registered in the State of Connecticut.
- C. All fire protection submittals shall be submitted in a single package. "Piece-Meal" or "Partial" submittals will not be accepted, and will be rejected and returned without review, unless prior approval from the Engineer has been obtained. NO EXCEPTIONS.
 - 1. An index shall be provided indicating:
 - a. A complete shop drawing log depicting ALL submittals to be provided for the Division, whether included in the full package or not. Log shall be updated to reflect the submittals provided.
 - b. Specification section.
 - c. Product.
 - d. Plan code.
 - e. Supplier, Manufacturer, Model Number, Contact List, etc.
- D. Fire protection long lead items are excluded from requirement but must be submitted complete in their entirety by specification section, when provided.
- E. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed.
- F. Provide shop drawings for all devices specified under equipment specifications for all systems, materials, equipment, and/or devices. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures) of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one (1) time. No consideration will be given to a partial shop drawing submittal.
 - 1. Equipment shop drawings shall contain full range performance curves, graphs, tables, or other pertinent data which clearly indicates operational range of a given unit size. Computer generated/plotted curves, based solely on design performance, will not be accepted.
 - 2. All specific options and/or alternatives shall be clearly indicated. Failure to do so shall be grounds for rejection.
- G. Submittals shall be marked with the trade involved, i.e., HVAC, plumbing, fire protection, etc. and the specific associated specification section.

- H. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- I. Failure to submit shop drawings in ample time for review shall not entitle the Contractor to an extension of Contract time. No claim for extension by reason of such default will be allowed, nor shall the Contractor be entitled to purchase, furnish and/or install equipment which has not been reviewed by the Engineer. The Contractor shall incur all costs associated with delay of construction due to equipment and/or materials arriving late due to late or improper shop drawing submittal.
- J. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- K. Acceptance rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not indicate that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.
- L. Acceptance of shop drawings shall not apply to quantity nor relieve Contractor of his responsibility to comply with intent of Drawings and Specifications.
- M. Acceptance of shop drawings is final and no further changes will be allowed without the written consent of the Engineer.
- N. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- O. Conform the Fire Protection work to the requirements herein. Provide offsets, fittings, drains, and accessories which may be required to accommodate structural, HVAC, plumbing, existing conditions, etc. Investigate the structural and finish conditions affecting the work and arrange the work accordingly. Provide such piping, fittings, valves, and accessories as may be required to meet such conditions.

1.13 CHANGES IN WORK

- A. Change Order is a written order to the Contractor signed by the Owner and the Architect, issued after Contracts have been awarded, authorizing a change in the work or an adjustment in the Contract sum or the Contract time. A Change Order signed by the Contractor indicates his agreement therewith, including the adjustment in the Contract sum or the Contract time.
- B. All changes in the work shall follow the recommendations of the AIA "General Conditions of the Contract for Construction", Article 7.

1.14 MANUFACTURER'S IDENTIFICATION

- A. All component parts of each item of equipment or device shall bear the manufacturer's nameplate giving name of manufacturer, description, size, type, serial and model number, electrical characteristics, etc., in order to facilitate maintenance or replacement. The nameplate of a Contractor or distributor will not be acceptable.

- B. All material and equipment for the electrical portion of the mechanical systems shall bear the label of or be listed by UL, or other accredited authoritative agencies or testing organizations approved by the authority having jurisdiction.

1.15 RECORD DRAWINGS

- A. Refer to Section 017839 "Project Record Documents". Maintain at the job site a record set of Sprinkler Drawings on which any changes in location or routing of all equipment, materials, and access panels shall be recorded.
- B. At the end of construction, the Contractor shall provide the Owner with a complete set of As-Built Drawings, including all updated coordination drawings, ductwork, and piping plans.
- C. If electronic copies of the contract documents are made available to the Contractor for use in production of As-Built documentation, the Contractor assumes responsibility for completeness and accuracy of the As-Built documents. Translation or manipulation of electronic documents provided to the Contractor is the responsibility of the Contractor.

1.16 MATERIALS AND WORKMANSHIP

- A. All materials and apparatus required for the work, except as otherwise specifically indicated, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected, and finished in every detail and be so selected and arranged as to fit properly into the building spaces. Where no specific type or quality of material is given, a first-class standard article as accepted by industry standards shall be furnished.
- B. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers, and laborers required to unload, transfer, erect, connect, adjust, start, operate, and test each system.
- C. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- D. All labor for installation of mechanical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous, or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.17 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury, or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place, and completely connecting equipment supplied under each Section. Work under each

Section shall also include exercising special care in handling and protecting equipment and fixtures and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Ensure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.18 BASES AND SUPPORTS

- A. Unless otherwise specifically noted, the Contractor shall furnish all necessary supports, rails, framing, bases, and piers required for all equipment furnished under this Division.
- B. Unless otherwise indicated in individual trade Sections, pumps, fans, air handlers, boilers, chillers, tanks, compressors, and other rotating machinery shall be mounted on a minimum of 4-inch-high concrete pads which shall be furnished and installed per the Structural Drawings. All pads shall be extended not less than 4 inches beyond machine base in all directions and sufficient for seismic anchoring with top edge chamfered. Shop drawings of all foundations and pads shall be submitted to the Engineer for review before they are constructed. The Mechanical Contractor shall field coordinate all required dimensional and necessary loading information.
- C. Construction of foundations, supports, pads, bases, and piers, where mounted on the floor, shall be of the same finish quality as the adjacent and surrounding flooring material.
- D. Unless otherwise shown, all equipment shall be securely attached to the building structure in an acceptable manner. Attachments shall be of a strong and durable nature; any attachments that are insufficient, in the opinion of the Engineer, shall be replaced as directed without extra cost to the Owner.
- E. All equipment supports shall be designed and constructed such that the equipment will be capable of resisting both vertical and horizontal movement. The equipment shall be positively anchored to the bases or supports to resist vertical movement. The equipment and its supports shall be provided with suitable restraints to resist horizontal movement from any direction as dictated by applicable seismic Codes.

1.19 SLEEVES, INSERTS, AND ANCHOR BOLTS

- A. The Contractor shall provide, set in place, and be held responsible for the location of all sleeves, inserts, and anchor bolts required for the work. In the event that failure to do so requires cutting and patching of finished work, it shall be done at the Contractor's expense.
 - 1. It is the responsibility of the Contractor to furnish cast-in-place sleeves, inserts, and anchors in sufficient time to be installed during initial concrete pours. Where job schedules make this impossible, coordinate and obtain acceptance from the Structural Engineer for alternate installation methods.
- B. All pipes and conduits passing through floors, walls, or partitions shall be provided with sleeves having an inside diameter 1-inch larger than the outside diameter of the pipe, conduit, or insulation enclosing the pipe.
- C. Penetrations through fire-rated walls, ceilings, and all floors (except slab on grade) in which piping or ducts pass shall be filled solidly with acceptable fire-stopping material.

- D. When ducts, piping, or conduit penetrate the floor of a mechanical room located above an occupied space, such penetrations shall be made completely watertight, such that a liquid leak shall not pass through the penetration.

1.20 FIRESTOPS AND SEALS

- A. Refer to Section 078413 "Penetration Firestopping" for additional and more specific information and ASTM E 814 and F&T Ratings.
- B. Firestopping systems shall be submitted as shop drawing.
- C. Penetrations through fire-rated walls, ceiling, or floors shall be sealed with a UL approved firestop fitting classified for an hourly rating equivalent to the fire rating of the wall, ceiling, or floor.
- D. Through wall and floor seals shall be used to provide a positive means of sealing pipes or ducts which pass through the concrete foundation of a structure below grade or below ground water level. Seals shall also be used at entry points through concrete walls or floors which must be sealed.
- E. All piping and conduit penetrations through the roof shall be provided with Pate Type PCA pipe curb assemblies or acceptable equivalent. Coordinate installation details with the roofing system being used for the project.

1.21 CUTTING AND PATCHING

- A. Refer to Section 017300 "Execution". The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of work.
- B. Work under this Division shall include furnishing, locating, and setting inserts and/or sleeves required before the floors and walls are built or be responsible for cutting, drilling, or chopping where sleeves and inserts were not installed or correctly located. The Contractor shall do all drilling required for the installation of hangers.
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him

1.22 SCAFFOLDING, RIGGING, HOISTING

- A. The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

1.23 WATERPROOFING

- A. Where any work pierces waterproofing, including waterproof concrete and floors in wet areas, the method of installation shall be reviewed by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking, and flashing required to make openings absolutely watertight.

1.24 ACCESSIBILITY AND ACCESS PANELS

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the work.
- B. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include, but not be limited to motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- C. Access doors in walls, ceilings, floors, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.
- D. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- E. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance, and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner.
- F. Permanent ladders for access to equipment when shown on Plans shall be furnished and installed. Coordinate exact requirements in field.

1.25 TEMPORARY OPENINGS

- A. The Contractor shall ascertain from an examination of the Drawings whether any special temporary openings in the building will be required for the admission of apparatus provided under this Division and shall coordinate the requirements accordingly. In the event of failure of the Contractor to give sufficient notice in time to arrange for these openings during construction, the Contractor shall assume all costs of providing such openings thereafter.

1.26 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner's representative.
- B. The Engineer and the Owner shall be notified of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.27 TAGS AND CHARTS

- A. Each valve and piece of apparatus under this Division shall be provided with suitable brass or laminated plastic tags and ceiling tag securely fastened with brass chains, screws, or rivets. Equipment shall be numbered with laminated plastic tags or neatly stenciled letters 2 inches high using designations in equipment schedules and/or shall conform to a directory indicating number, location, and use of each item. Directories shall be prepared under each Section and shall be glass framed.
 - 1. Directory shall indicate valve tag number and the unit number, floor/area branch line, main line, service, or other pertinent data to quickly and easily identify the valve's purpose.

1.28 ESCUTCHEONS

- A. The Contractor shall provide escutcheons on pipes wherever they pass through floors, ceilings, walls, or partitions in finished visible locations. See Section 078413 "Penetration Firestopping" for further requirements.

1.29 PAINTING

- A. All finish painting in completed areas shall be performed per Division 09 of the Specifications.
- B. All materials shipped to the job site under this Division, such as grilles, registers, and/or radiation covers, shall have standard manufacturer's finish, unless otherwise specified.
- C. The Contractor shall paint conduits, pipe, and equipment wherever it can be seen through a register or louver. Paint shall not cover-up labels and other identifying items. Paint shall be flat black, rust preventative type.
- D. All uninsulated outdoor piping and fittings shall be properly primed with zinc-rich primer and finished with a minimum of two (2) coats of high-grade exterior enamel.

1.30 PIPE EXPANSION

- A. All pipe connections shall be installed to allow for freedom of movement of the piping during expansion and contraction without springing. Provide engineered design, layout, details, and fabrication, submitted with registered professional engineer sign and seal, of swing joints, expansion loops, and expansion joints with proper anchors and guides. Pay particular attention to plastic piping with high coefficients of expansion.
 - 1. Consideration of required seismic lateral restraints shall be given when anchoring piping and making provision for expansion.

1.31 ELECTRICAL CONNECTIONS

- A. Unless otherwise specified, all wiring shall be furnished and installed per Division 26 Specifications.
- B. The Contractor furnishing equipment shall furnish the motor controller required for the equipment. Provide properly sized overload heaters and all required accessories with all motor controllers. See Division 26 for motor controller requirements.
- C. All power wiring shall be furnished and installed per Division 26 complete from power source to motor or equipment junction box including power wiring through the motor controller and proper

means of disconnect per NEC and Division 26. The Division 26 Contractor shall provide all disconnects, unless noted otherwise.

1.32 QUIET OPERATION

- A. Equipment and material used in the various systems described herein shall not produce a sound level greater than 55 decibels in the area served. If noise level is deemed objectionable by the Owner/Engineer, the Contractor shall test and record sound levels in the presence of the Owner/Engineer. The sound level shall be observed on the "A" weighting network of a sound level or sound survey meter. The ASHRAE "Guide and Data Book" provides a means to determine sound level of mechanical equipment when the total of background plus equipment sound levels exceeds the minimum acceptable equipment sound level.
- B. If objectionable noises or vibrations of any magnitude are produced and transmitted to occupied portions of the building by apparatus, piping, ducts, or other parts of the mechanical work, the Contractor shall make such changes or additions as necessary without extra cost to the Owner.

1.33 MAINTENANCE

- A. The Contractor shall provide the necessary skilled labor to assure the proper operation and to provide all required current and preventative maintenance for all equipment and controls provided under this Division until final acceptance of the building by the Owner. The Contractor shall not assume acceptance of the building by the Owner until he receives written notification.
- B. The Contractor shall receive calls for any and all problems experienced in the operation of the equipment provided under this Division and he shall take steps to immediately correct any deficiencies that may exist.
- C. The Contractor shall provide a check list and shall put a copy of it in the boiler or main mechanical room. The check list shall itemize each piece of equipment furnished under his Section.
 - 1. The Contractor shall certify on this check list that he has examined each piece of equipment and that, in his opinion, it is operating as intended by the manufacturer, it has been properly lubricated, and that all necessary current and preventative maintenance has been performed as recommended by the manufacturer and by good and accepted practice.
- D. Where normal preventative maintenance for any piece of equipment requires special tools, the Contractor shall furnish the appropriate tools for that piece of equipment (i.e., special filter removal hooks, valve wrenches, etc.).

1.34 LUBRICATION

- A. All equipment installed under this Contract having moving parts and requiring lubrication shall be properly lubricated according to manufacturer's recommendations prior to testing and operation. Any such equipment discovered to have been operated before lubrication by the Contractor is subject to rejection and replacement at no additional cost to the Owner. Units furnished with sealed bearings are exempted.
- B. The Contractor shall furnish and install, as appropriate, all equipment requiring lubrication, Zerk pressure gun grease fittings or sight gravity-feed oilers equipped with shutoff and needle valve adjustment. Units furnished with sealed bearings and lifetime lubrication are exempted. All fittings and oilers are to be fully accessible for lubrication with equipment which does not require

special adapters. Where fittings would be otherwise inaccessible, furnish and install extended grease lines.

1.35 CLEANING

- A. The Contractor shall be responsible for keeping the jobsite clean, safe, and neat throughout the duration of construction. The Contractor shall clean up his own debris daily and shall coordinate removal of rubbish and debris with the General Contractor/Construction Manager.
 - 1. No debris, construction materials, cigarette butts, coffee cups, etc., shall be left above suspended ceilings.
- B. The Contractor shall thoroughly clean and flush all piping and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.
- C. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned, and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.
- D. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- E. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris, and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

1.36 OPERATING INSTRUCTIONS

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment, and maintenance of all equipment furnished. The Contractor shall give at least 72 hours' notice to the Owner and the Engineer in advance of this period.
- B. The Contractor, in the above-mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this Division.
- C. The appropriate Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
- D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, boilers. These letters will be bound into the operating and maintenance books.
- E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

1.37 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.
- B. Where requested by the Engineer, a factory-trained service engineering representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service engineering representative shall supervise the initial operation of the equipment and instruct the personnel responsible for operation and maintenance of the equipment. The service engineering representative shall notify the Contractor in writing that the equipment was installed according to manufacturer's recommendations and is operating as intended by the manufacturer.

1.38 GUARANTEES

- A. The Contractor shall guarantee all equipment, material, and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner, unless otherwise noted.
- B. During this guarantee period, all defects developing through faulty equipment, materials, or workmanship shall be corrected or replaced immediately by the Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 210100

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

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

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Jay R. Smith Mfg. Co.
 - 2. Zurn Industries, LLC
- B. Description: Manufactured, Dura-coated or Duco-coated or galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc
3. GPT; an EnPro Industries company.
4. Metraflex Company (The)
5. Proco Products, Inc.

- B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Carbon steel or composite plastic.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company
4. Metraflex Company (The)
5. Proco Products, Inc.

- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

- C. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Description: Non-shrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

- B. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

- C. Design Mix: 5000-psi, 28-day compressive strength.

- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke- stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping." Fire-seal shall be UL Listed, approved and tested fire and/or smoke sealing material installed in all fire and/or smoke rated floors and partitions in accordance with NFPA, local code and manufacturer's recommendations

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Use grout to seal around the outside of stack-sleeve fittings.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Galvanized steel pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized steel pipe sleeves with sleeve-seal system
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized steel pipe sleeves or Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Galvanized steel pipe sleeves or Sleeve-seal fittings.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 210517

SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Plate, Brass Type: With polished, chrome-plated and rough brass finish; concealed hinge; and spring-clip fasteners.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast Brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece cast brass with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece stamped steel with polished, chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece cast brass with rough-brass finish, or one-piece stamped steel with chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece cast brass with rough-brass finish or one-piece stamped steel chrome-plated finish.
 - 2. Escutcheons for Existing Piping to Remain:
 - a. Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-plate, brass with concealed hinge and rough-brass finish or split-plate, stamped steel with concealed hinge with chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split-plate, brass with concealed hinge and rough-brass finish or split-plate, stamped steel with concealed hinge with chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor plate.
 - 2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 210518

SECTION 210523 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Iron butterfly valves with indicators.
 - 2. Check valves.
 - 3. Iron OS&Y gate valves.
 - 4. Trim and drain valves.

1.3 DEFINITIONS

- A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- B. NRS: Non-rising stem.
- C. OS&Y: Outside screw and yoke.
- D. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
- D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
 - 1. Main Level: HAMV - Fire Main Equipment.
 - a. Level 1: HCBZ – Indicator Posts, Gate Valve.
 - b. Level 1: HLOT – Valves.
 - 1) Level 3: HLUG – Ball Valves, System Control.
 - 2) Level 3: HLXS – Butterfly Valves.
 - 3) Level 3: HMER – Check Valves.
 - 4) Level 3: HMRZ – Gate Valves.
 - 2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
 - a. Level 1: VQGU – Valves, Trim and Drain.
- B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
 - 1. Automated Sprinkler Systems:
 - a. Indicator posts.
 - b. Valves.
 - 1) Gate valves.
 - 2) Check valves.
 - a) Single check valves.
 - 3) Miscellaneous valves.
- C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.
- D. ASME Compliance:
 - 1. ASME B16.1 for flanges on iron valves.
 - 2. ASME B1.20.1 for threads for threaded-end valves.
 - 3. ASME B31.9 for building services piping valves.
- E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- F. NFPA Compliance: Comply with NFPA 24 for valves.
- G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.
- H. Valve Sizes: Same as upstream piping unless otherwise indicated.
- I. Valve Actuator Types:

GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 IRON BUTTERFLY VALVES WITH INDICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Anvil International
2. NIBCO INC.
3. Tyco Fire Products LP
4. Victaulic Company
5. Zurn Industries, LLC

- B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless-steel.
6. Disc: Ductile iron, and EPDM or SBR coated.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Grooved-end connections.

2.3 CHECK VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Anvil International
2. NIBCO INC.
3. Reliable Automatic Sprinkler Co., Inc. (The)
4. Tyco Fire Products LP
5. Victaulic Company

- B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless-steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless-steel.
7. Hinge Shaft: Bronze or stainless-steel.
8. Hinge Spring: Stainless-steel.
9. End Connections: Flanged, grooved, or threaded.

2.4 IRON OS&Y GATE VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Hammond Valve
 2. NIBCO INC.
 3. Victaulic Company
 4. Watts; a Watts Water Technologies company
 5. Zurn Industries, LLC
- B. Description:
1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
 2. Minimum Pressure Rating: 175 psig.
 3. Body and Bonnet Material: Cast or ductile iron.
 4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
 5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
 6. Stem: Brass or bronze.
 7. Packing: Non-asbestos PTFE.
 8. Supervisory Switch: External.
 9. End Connections: Flanged, grooved or threaded.

2.5 TRIM AND DRAIN VALVES

- A. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company
 - c. NIBCO INC.
 - d. Potter Roemer LLC
 - e. Tyco Fire Products LP
 2. Description:
 - a. Pressure Rating: 175 psig.
 - b. Body Design: Two-piece.
 - c. Body Material: Forged brass or bronze.
 - d. Port size: Full or standard.
 - e. Seats: PTFE.
 - f. Stem: Bronze or stainless-steel.
 - g. Ball: Chrome-plated brass.
 - h. Actuator: Handlever.
 - i. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
 - j. End Connections for Valves NPS 2-1/2 and larger: Grooved ends.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

- A. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.
- B. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- C. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above the pipe center.
- E. Install valves in position to allow full stem movement.
- F. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION 210523

SECTION 210548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Pipe-riser resilient supports.
 - 5. Resilient pipe guides.
 - 6. Elastomeric hangers.
 - 7. Snubbers.
 - 8. Restraint channel bracings.
 - 9. Seismic-restraint accessories.
 - 10. Mechanical anchor bolts.
 - 11. Adhesive anchor bolts.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).
- D. CSBC: Connecticut State Building Code.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - 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.
 - 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

- B. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
 3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
 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. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - d. Pre-approval 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).

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements of the Connecticut State Building Code, unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approval OPA number from OSHPD, pre-approval by ICC-ES, or pre-

approval 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 pre-approved ratings are unavailable, 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Refer to General Notes on Structural Drawings for Seismic Load Criteria.
2. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four (4) times the maximum seismic forces to which they are subjected.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Novia; A Division of C&P
 - g. Vibration Eliminator Co., Inc.
 - h. Vibration Isolation
 - i. Vibration Mountings & Controls, Inc.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Ribbed or waffle pattern.
6. Infused non-woven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and/or elastomeric.
 - a. Surface Pattern: Ribbed and/or waffle pattern.
 - b. Infused non-woven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Novia; A Division of C&P
 - g. Vibration Eliminator Co., Inc.
 - h. Vibration Isolation
 - i. Vibration Mountings & Controls, Inc.
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Novia; A Division of C&P
 - g. Vibration Eliminator Co., Inc.
 - h. Vibration Isolation
 - i. Vibration Mountings & Controls, Inc.
2. Description: All-directional isolator with seismic restraints containing two (2) separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 PIPE-RISER RESILIENT SUPPORT

- ##### A. Description: All-directional, acoustical pipe anchor consisting of two (2) steel tubes separated by a minimum ½-inch-thick neoprene.
1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.

2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.6 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two (2) steel tubes or post-and-sleeve arrangement separated by a minimum ½-inch-thick neoprene.
 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.7 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Mountings & Controls, Inc.
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.8 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Vibration Mountings & Controls, Inc.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum ¼-inch air gap, and minimum ¼-inch-thick resilient cushion.

2.9 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. B-line, an Eaton business
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Part of Atkore International

- B. Description: MFMA-4, shop- or field-fabricated bracing 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; rated in tension, compression, and torsion forces.

2.10 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. B-line, an Eaton business
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. TOLCO
 5. Vibration & Seismic Technologies, LLC
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multi-functional steel connectors for attaching hangers to rigid channel bracings.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- E. 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 used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.11 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. B-line, an Eaton business
 2. Hilti, Inc.
 3. Kinetics Noise Control, Inc.
 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- 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 Pipe Supports: Secure pipes 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 is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Equipment Restraints:
 - 1. Install seismic snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125-inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- D. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

- G. 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.
- H. 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.
- I. 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 Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. 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 piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211313 "Wet-Pipe Sprinkler Systems" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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 post-connection testing has been approved), and with at least seven (7) days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four (4) of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to ninety percent (90%) of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

END OF SECTION 210548

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- D. Valve Schedules: Valve numbering scheme.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch-thick, with pre-drilled holes for attachment hardware.
 - 2. Letter Color: Red.
 - 3. Background Color: White.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.
 - 5. Minimum Letter Size: ¼-inch for name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 6. Fasteners: Stainless-steel rivets or self-tapping screws.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment-Label Schedule: For each item of equipment to be labeled, on 8½-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multi-layer, multi-color, plastic labels for mechanical engraving, 1/8-inch-thick, with pre-drilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.
- F. Minimum Letter Size: ¼-inch for name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Pre-printed, color-coded, with lettering indicating service and showing flow direction.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1½ inches high.
- E. Pipe-Label Colors:

1. Background Color: Red.
2. Letter Color: White.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with ¼-inch letters for piping-system abbreviation and ½-inch numbers.
 1. Tag Material: Brass, 0.032-inch-thick, with pre-drilled holes for attachment hardware.
 2. Fasteners: Brass wire-link chain, beaded chain or S-hook.
 3. Valve-Tag Color: Red.
 4. Letter Color: White.
- B. Valve Schedules: For each piping system, on 8½-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: Pre-printed or partially pre-printed, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 LABEL INSTALLATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install or permanently fasten labels on each major item of mechanical equipment.
- D. Locate equipment labels where accessible and visible.
- E. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting."

- F. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.3 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
1. Valve-Tag Size and Shape:
 - a. Wet-Pipe Sprinkler System: 2 inches round.

3.4 WARNING-TAG INSTALLATION

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

END OF SECTION 210553

SECTION 211313 - WET-PIPE SPRINKLER 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. Section includes complete demolition of existing, and provision of new building sprinkler systems, components, and accessories inside the building.
 - a. The facility is presently served by an existing 4-inch fire service, which rises through floor slab in Sprinkler Room C2095. This service is to be demolished and replaced with a new 6-inch fire service.
 - 2. Pipes, fittings, and specialties.
 - 3. Flexible connectors.
 - 4. Specialty valves.
 - 5. Sprinklers.
 - 6. Alarm devices.
 - 7. Pressure gages.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig minimum.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For all building wet-pipe sprinkler systems, existing to remain and new.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. HVAC hydronic piping.
3. HVAC ductwork.
4. HVAC equipment.
5. Items penetrating or attached to finished ceiling, including but not limited to the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers, motion sensors, smoke and or heat detectors, etc.
 - d. Electrical Equipment requiring clearances from sprinkler systems.

- B. Qualification Data: For qualified Installer and professional engineer.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.
- D. Welding certificates (For fabrication of pipe support, if used).
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six (6) spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code. (For fabrication of pipe support, if used.)

1.9 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
1. Notify Construction Manager and Owner's Director of Facilities no fewer than two (2) days in advance of proposed interruption of sprinkler service.
 2. Do not proceed with interruption of sprinkler service without Construction Manager's and Owner's Director of Facilities' written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
1. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: Five percent (5%), including losses through water-service piping, valves, and backflow preventers.
 - b. Sprinkler Occupancy Hazard Classifications:
 - 1) Offices, Classrooms, Toilet Rooms: Light Hazard.
 - 2) Corridors, Vestibules, Lobbies: Light Hazard.
 - 3) Cafeteria and Gymnasium: Light Hazard.
 - 4) Stage: Ordinary Hazard, Group 2.
 - 5) Libraries except Large Stack Areas: Light Hazard.
 - 6) Commercial Kitchen Areas: Ordinary Hazard, Group 1.
 - 7) Building Service Areas: Ordinary Hazard, Group 1.
 - 8) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - 9) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - 10) Storage Areas, incl. Janitor's Closets: Ordinary Hazard, Group 2.
 - 11) Libraries-Large Stack Areas: Ordinary Hazard, Group 2.
 2. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
 3. Maximum Protection Area per Sprinkler: According to UL listing.
 4. Maximum Protection Area per Sprinkler:
 - a. Light Hazard Areas: 225 sq. ft. (if all NFPA 13 requirements for this coverage are met).

b. Ordinary Hazard Areas: 130 sq. ft.

D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and the Connecticut State Building Code.

1. Refer to General Notes on Structural Drawings for Seismic Load Criteria.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight (Schedule 40), Black- or Galvanized-Steel Pipe: UL/FM, ASTM A 53, Type E, Grade B, or ASTM A795, Type E, Grade A. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: UL/FM, ASTM A 135, Type E, Grade A. Plain end.

C. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized- and Uncoated-Steel Couplings: ASTM A 865, threaded.

E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Galvanized and Uncoated, Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

G. Malleable- or Ductile-Iron Unions: UL 860.

H. Cast-Iron Flanges: ASME 16.1, Class 125.

I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: EPDM rubber gasket.

a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.

b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Anvil International

b. Tyco Fire Products LP

c. Victaulic Company

2. Pressure Rating: 175-psig minimum.

3. Painted Grooved-End Fittings for Steel Piping: ASTM A 47, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.

4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
 - 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Automatic (Ball Drip) Drain Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The)
 - b. Tyco Fire Products LP
 - 2. Standard: UL 1726.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Type: Automatic draining, ball check.
 - 5. Size: NPS 3/4.
 - 6. End Connections: Threaded.

2.4 BACKFLOW PREVENTER

- A. Double-Check Detector Backflow-Prevention Assemblies:
 - 1. Subject to compliance with requirements, provide product by one (1) of the following:
 - a. Ames Fire & Waterworks
 - b. FEBCO
 - c. Watts; a Watts Water Technology Company
 - 2. Standards: ASSE 1015.
 - 3. Operation: Continuous-pressure applications unless otherwise indicated.
 - 4. Pressure Loss: 6 psig maximum, through middle third of flow range.
 - 5. Size: 6 inches.
 - 6. Design Flow Rate: 500 gpm (Wet-Pipe System, Ordinary Hazard Group 2, 0.20 GPM/1500 SF, plus 200 gpm hose allowance assigned to stage standpipe system.)
 - a. Note: Water demand in excess of this minimum design flow, known as "overage", is expected; the actual amount of overage will be determined from Contractor's hydraulic calculations generated from working Shop Drawings.
 - 7. Selected Unit Flow Range Limits (UL rating): 0 to 1400 gpm (minimum).
 - 8. Pressure Loss at Design Flow Rate: 4 psig maximum for Basis-of-Design model and 6-inch size.
 - 9. Body: Cast iron with interior lining that complies with AWWA C550 or that is FDA approved, or stainless steel for NPS 2-1/2 and larger.
 - 10. End Connections: Flanged for NPS 2-1/2 and larger.

11. Configuration: Designed for horizontal, straight-through flow.
12. Construction: NSF 61-Annex G lead-free certified.
13. Accessories:
 - a. Listed OS&Y gate valves with flanged ends and supervisory switches on inlet and outlet.
 - b. Detector Assembly to monitor unauthorized use of water from the fire protection service/system; readout in CFM. Metered bypass detector branch shall have backflow preventer type matching main backflow preventer, that is, a double check backflow preventer.
14. Basis-of-Design:
 - a. Watts; **LF757 DCDA-OSY**
 - b. Wilkins; **350DA-CFM**
 - c. Wilkins; **350ASTDA-CFM**

2.5 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Anvil International
 - b. Tyco Fire Products LP
 - c. Victaulic Company
2. Standard: UL 213.
3. Pressure Rating: 175-psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The)
 - b. Tyco Fire Products LP
 - c. Victaulic Company
2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. AGF Manufacturing Inc.
 - b. Tyco Fire Products LP
 - c. Victaulic Company
2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

D. Flexible Sprinkler Hose Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. FlexHead Industries, Inc.
 - b. Gateway Tubing, Inc.
 - c. Victaulic Company
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175-psig minimum.
5. Size: Same as connected piping, for sprinkler.
6. Maximum Length: 5 feet.

2.6 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 1. Reliable Automatic Sprinkler Co., Inc. (The)
 2. Tyco Fire Products LP
 3. Victaulic Company
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- D. Automatic Sprinklers with Heat-Responsive Element shall meet the following criteria:
 1. Non-residential Applications: UL 199.
 2. Quick Response.
 3. Characteristics: Nominal ½-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- E. Sprinkler Finishes: Chrome plated, bronze and painted.
- F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting, Standard or Recessed Pendent: Chrome-plated steel, one-piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one-piece, flat.

G. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The)
 - b. Tyco Fire Products LP
 - c. Victaulic Company
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.7 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Potter Electric Signal Company, LLC
 - b. System Sensor
 - c. Watts; a Watts Water Technologies company
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two (2) single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

C. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Potter Electric Signal Company, LLC
 - b. System Sensor
 - c. Tyco Fire Products LP
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

D. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell International company
 - b. Kennedy Valve Company; a division of McWane, Inc.
 - c. Potter Electric Signal Company, LLC
 - d. System Sensor
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Electrically Operated Alarm Bell (if Required by AHJ):

1. Basis-of-Design:
 - a. Potter Electric Signal **Series PBA-AC** with **Model BBK-1**
2. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Fire-Lite Alarms; a Honeywell company
 - b. Notifier; a Honeywell company
3. Standard: UL 464.
4. Type: Vibrating, metal alarm bell; 120 VAC
5. Backbox: Weatherproof.
6. Size: 8-inch minimum diameter.
7. Finish: Red-enamel factory finish, suitable for outdoor use.

2.8 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 1. AGF Manufacturing Inc.
 2. AMETEK, Inc.
 3. Ashcroft Inc.
 4. Brecco Corporation
 5. WIKA Instrument Corporation
- B. Standard: UL 393.
- C. Dial Size: 3½- to 4½-inch diameter.
- D. Pressure Gage Range: 0- to 250-psig minimum.
- E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Arrange for a new fire-hydrant flow test according to NFPA 13 and NFPA 291 if existing area flow test results are more than one (1) calendar year prior to project start. Use results for system design calculations required in "Quality Assurance" Article. All associated flow test costs shall be included in the Bid.
- B. Report test results promptly and in writing.

3.2 BUILDING SPRINKLER/STANDPIPE DISTRIBUTION

- A. Building sprinkler/standpipe system distribution shall be served by two (2) alarm check valve risers (R1 and R2), each with multiple sprinkler zones, one (1) zone for each floor. General arrangement:
 - 1. Riser 1: Serves Building Part C, with a sprinkler zone for each of two (2) floors, and supply to Stage standpipe system.
 - 2. Riser 2: Serves Building Parts A & B, with a sprinkler zone for each of three (3) upper floors; in addition, a subzone SZCA is provided on the 1st floor zone branch main which supplies the Basement sprinkler system.
- B. For each standpipe riser, provide a supervised control valve and flow switch.
- C. For each of the sprinkler zones, provide a sprinkler zone control assembly (SCZA), and a wet inspector's test connection, located in a hydraulically remote location of the sprinkler zone, in a secured area coordinated with the Owner's Director of Facilities.
- D. The Fire Department piping connection to the building sprinkler/standpipe distribution piping shall be located downstream of the fire service backflow preventer and upstream of the R1 and R2 riser control valves. Refer to Detail on Drawing P801.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of existing sprinkler system piping to remain and proposed new sprinkler system piping. Install piping as indicated on Contractor-generated coordinated and approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 and the State of Connecticut Building Code requirements for seismic-restraint device materials and installation. Refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler piping so as to minimize the number of auxiliary low point drains required.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building. Also, at base of exterior FDC riser.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. Refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- M. Install pressure gages on main riser, on each zone feed main and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install auto drip valves to as to fully drain trapped portions of piping upstream of check valves and eliminate freeze potential. Pipe drip to floor drain or other waste receptor with air gap per code.

3.6 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of 2 x 2 acoustical ceiling panels, unless specifically noted otherwise on the Drawings.
- B. Install sprinklers in suspended ceilings in center or quarter points of 2 x 4 acoustical ceiling panels, unless specifically noted otherwise on the Drawings.
- C. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- D. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Notify the authority having jurisdiction and the Owner's representative at least two (2) days in advance of all tests and inspections.
 - 2. All final acceptance tests and inspections shall be performed in the presence of the Owner's representative and the authority having jurisdiction, and their signatures shall be obtained on final acceptance test and inspection written documentation.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire department equipment.
- C. Arrange and pay for inspection/testing of the new fire service backflow preventer required and performed by the Water Utility.
- D. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's sprinkler system maintenance contractor to adjust, operate, and maintain specialty valves, and to become familiar with the locations of all control valves and inspector's tests.

3.11 PIPING SCHEDULE

- A. Piping between Fire Department Connections and check valves, and Other Normally Dry Piping Systems: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints. NPS 2 and smaller may also be Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one (1) of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be one (1) of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 3. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Pendent sprinklers; concealed type unless specifically noted otherwise.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
 - 5. Special Applications: Extended-coverage sprinklers where indicated.
 - 6. Refer to Sprinkler Schedule on the Drawings.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Pendent Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
 - 3. Refer to Sprinkler Schedule on the Drawings.

END OF SECTION 211313

SECTION 220100 - GENERAL CONDITIONS FOR PLUMBING TRADE

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. General Conditions, Supplementary Conditions, and Division 01 paragraphs may be repeated in this Division for emphasis or for inclusion of more stringent/additional related requirements. Such repetition shall not be construed to reduce the requirements of those Divisions nor to eliminate other requirements under those Divisions.

1.2 DESCRIPTION

- A. The General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions shall be assumed to be omitted if not repeated therein.
- C. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of Division 22.
- D. The following information contains specifications of Work in connection with, and in addition to, this Division:
 - 1. All drawings associated with the project.
 - 2. All specifications associated with the project.
- E. Divisions of work responsibilities shall be defined and directed by the General Contractor or Construction Manager.

1.3 INTENT

- A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.
- B. Furnish, deliver, and install any apparatus, appliance, material, or Work not shown on Drawings but mentioned in the Specifications, or vice versa, or any incidental accessories necessary to make the Work complete and perfect in all respects and ready for operation, even if not particularly specified, under their respective Section without additional expense to the Owner.
- C. Include in the work minor details not usually shown or specified but necessary for proper installation and operation, as though they were hereinafter shown or specified.
- D. Provide Engineer written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules, or regulations of authorities having jurisdiction; and any necessary items of Work omitted. In the absence of such written notice, it is mutually agreed that Work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

- E. The Work indicated is diagrammatic. The Architect and/or Engineer may require as part of this Contract, the relocation of devices to reasonable distances from the general locations shown.
- F. Verbal clarifications of the Drawings or Specifications during the bid period are not to be relied upon. Refer any questions or clarifications to the Engineer as indicated in Division 00.

1.4 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. (Do not scale the Drawings.) Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect.
- B. Closely follow Drawings in layout of Work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom. Where space conditions appear inadequate, Engineer shall be notified before proceeding with installations.
- C. Engineer may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, include the item or arrangement of better quality, greater quantity, or higher cost in the Contract price. The Engineer shall decide on the item and the manner in which the work shall be installed.

1.5 SURVEYS AND MEASUREMENTS

- A. Before submitting a Bid, the Contractor shall visit the site and shall become thoroughly familiar with all conditions under which the work will be installed. Contractor will be held responsible for any assumptions, omissions, or errors made as a result of failure to become familiar with the site and the Contract Documents.
- B. Base all measurements, both horizontal and vertical, from established benchmarks. All Work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the Work.
- C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or the intent of the Drawings and Specifications, notify the Engineer do not proceed with that Work until instructions have been received from the Engineer.

1.6 CODES AND STANDARDS

- A. The Codes and Standards listed below apply to all Work. Where Codes or Standards are mentioned in these Specifications, follow the latest edition or revision.
- B. The current adopted editions of the following State or local Codes apply:

2022 State of Connecticut Building Code/2021 IBC with CT Amendments
2022 State of Connecticut fire Safety Code/2021 IFC with CT Amendments
2022 International Existing Building Code (including CT Amendments)
2022 International Mechanical Code (including CT Amendments)
2022 International Plumbing Code (including CT Amendments)
2022 International Energy Conservation Code (including CT Amendments)
2022 National Electric Code (NFPA 70/2020 CT Amendments)

2017 ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities
2015 International Plumbing Code and referenced publications
NFPA 54/2021, National Fuel Gas Code
NFPA 72/2019, National Fire Alarm Code
AWWA Standards
Factory Mutual Approval Guide: latest edition
Pipe Hangers and Supports: MSS SP-58
UL Compliance
Local Building Code

C. The following Standards shall be used where referenced by the following abbreviations:

AABC Associated Air Balance Council
ACGIH American Conference of Governmental Industrial Hygienists
ADC Air Diffusion Council
AGA American Gas Association
AIA American Institute of Architects
AMCA Air Moving and Conditioning Association
ANSI American National Standards Institute
API American Petroleum Institute
ARI Air Conditioning and Refrigeration Institute
ASE Association of Safety Engineers
ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME American Society of Mechanical Engineers
ASPE American Society of Plumbing Engineers
ASTM American Society of Testing and Materials
AWS American Welding Society
AWWA American Water Works Association
CGA Compressed Gas Association
CSA Canadian Standards Association
CISPI Cast Iron Soil Pipe Institute
EJMA Expansion Joint Manufacturing Association
EPA Environmental Protection Agency
FM Factory Mutual Insurance Association
FSSC Federal Specification
HIS Hydraulic Institute Standards
IBR Institute of Boiler and Radiator Manufacturers
IEEE Institute of Electrical and Electronics Engineers
IRI Industrial Risk Insurers
ISO Insurance Services Office
MCAA Mechanical Contractors Association of America
MSS Manufacturers Standardization Society
NBS National Bureau of Standards
NEBB National Environmental Balancing Bureau
NEMA National Electrical Manufacturers Association
NFPA National Fire Protection Association
NOFI National Oil Fuel Institute
NRC National Research Council
NSC National Safety Council
NSF National Sanitation Foundation
OSHA Occupational Safety and Health Administration
PDI Plumbing and Drainage Institute
SAMA Scientific Apparatus Manufacturers Association
SBI Steel Boiler Industry (Division of Hydronics Institute)
SMACNA Sheet Metal and Air Conditioning Contractors National Association
STI Steel Tank Institute

UL Underwriters' Laboratories

- D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction, and the requirements of all Governmental departments having jurisdiction.
- E. Include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus, and Drawings in order to comply with all applicable laws, ordinances, rules, and regulations, whether or not shown on Drawings and/or specified.

1.7 PERMITS AND FEES

- A. Give all necessary notices, obtain all permits, pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Work. File all necessary Drawings, prepare all Documents, obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspections for Work, and deliver a copy to the Engineer before request for acceptance and final payment for the Work.

1.8 SEISMIC RESTRAINT

- A. General: This project is in a seismic zone per State and/or Local Codes and Ordinances and all materials and equipment shall be installed, supported, and seismically restrained accordingly. Verify current seismic requirements based on project location and with Code requirements.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those required for this Project in material, design, and extent.
- C. Shop Drawings: Show designs and calculations, certified by a professional engineer, for the following:
 - 1. Design Calculations: Calculations for selection of vibration isolators, design of vibration isolation bases, design of seismic supports, and selection of seismic restraints for all equipment and materials.
 - 2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.
 - 3. Seismic Restraint Details: Detail fabrication and attachment of restraints, supports, and snubbers.
- D. Installation: Installation shall be carried out in strict accordance with the Seismic Engineer's submittal, current Code, accepted standards, and the equipment and material manufacturers' recommendations.

1.9 COORDINATION

- A. Carry out all work in conjunction with other trades and give full cooperation in order that all Work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the General Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, access doors, etc. required by other trades.

- B. Contractors are required to examine all the Project Drawings and mutually arrange Work so as to avoid interference. In general, ductwork, heating piping, sprinkler piping, and drainage lines take precedence over water, gas, and electrical conduits. The Engineer regarding the arrangement of Work, which cannot be agreed upon by the Contractors, will make final decisions.
- C. Where the Work of the Contractor will be installed in close proximity to or will interfere with Work of other trades, assist in working out space conditions to make a satisfactory adjustment.
- D. If Work is installed before coordinating with other Divisions or so as to cause interference with Work of other Sections, the Contractor causing the interference will make necessary changes to correct the condition without extra charge to the Owner.
- E. Initial contact and coordination have been conducted with utility entities for the purpose of the preparation of Bid Documents. The Contractor shall coordinate all final specific utility requirements.

1.10 ACCEPTANCES

- A. The equipment, materials, Workmanship, design, and arrangement of all Work installed are subject to the review of the Engineer.
- B. Within thirty (30) days after the awarding of a Contract, submit to the Engineer for review a list of manufacturers of equipment proposed for the Work. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.
 - 1. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, notify the Engineer, in writing, within thirty (30) days of the awarding of the Contract. In such instances, deviations may be made pending acceptance by the Engineer or the Owner's representative.
- C. Where any specific material, process, or method of construction or manufactured article is specified by reference to the catalog or model number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- D. If material or equipment is installed before shop drawing review, liability for its removal and replacement is assumed by the Contractor, at no extra charge to the Owner, if, in the opinion of the Engineer, the material or equipment does not meet the intent of the Drawings and Specifications.
- E. Failure on the part of the Engineer to reject shop drawings or to reject Work in progress shall not be interpreted as acceptance of Work not in conformance with the Drawings and/or Specifications. Correct Work not in conformance with the Drawings and/or Specifications whenever non-conformance is discovered.

1.11 EQUIPMENT DEVIATIONS

- A. Refer to Section 016000 "Product Requirements". Where the Contractor proposes to deviate (substitute or provide an equivalent) from the equipment or materials as hereinafter specified, he shall do so by making a request in writing. The Contractor shall state in his request whether it is a substitution or an equivalent to that specified and the amount of credit or extra cost

involved. A copy of said request shall be included in the Base Bid with manufacturer's equipment cuts. The Base Bid shall be based on using the materials and equipment as specified and scheduled with no exceptions. Equipment Manufacturers Scheduled on Drawings are considered Base Bid and any other acceptable manufacturers listed in the specifications is considered a substitution and equipment deviation and subject to the requirements for equipment substitution and deviation. When any alternate manufacturer does not qualify acceptable, as determined by the Engineer, provide the Base Bid manufacturer at no additional cost to Owner.

- B. In these Specifications and on the accompanying Drawings, one (1) or more makes of materials, apparatus, or appliances may have been specified for use in this installation. This has been done for convenience in fixing the standard of workmanship, finish, and design required for installation. In the event that only one (1) manufacturer of a product is specified, and it is found that the manufacturer has discontinued the product, the Contractor shall use an acceptable equivalent product that meets the requirements of an equivalent product, as noted below, and has all the features of the originally specified product. The details of workmanship, finish, and design, and the guaranteed performance of any material, apparatus, or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.
- C. Where no specific make of material, apparatus, or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineer's review.
- D. Where two (2) or more names are given as equivalents, the Contractor must use the specified item or one (1) of the named equivalents. Where one (1) name only is used and is followed by the words "or acceptable equivalent", the Contractor must use the item named or he may apply for an equipment deviation through the prescribed manner in accordance with this Specification.
- E. Equipment, material, or devices submitted for review as an "accepted equivalent" shall meet the following requirements:
 - 1. The equivalent shall have the same construction features such as, but not limited to:
 - a. Material thickness, gauge, weight, density, etc.
 - b. Welded, riveted, bolted, etc., construction.
 - c. Finish, undercoatings, corrosion protection.
 - 2. The equivalent shall perform with the same or better operating efficiency.
 - 3. The equivalent shall have equal or greater reserve capacity.
 - 4. The equivalent shall be locally represented by the manufacturer for service, parts, and technical information.
 - 5. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as AMCA or ARI labels.
- F. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Designers of Record at the expense of the Contractor and at no additional cost to the Owner.
- G. Where such accepted deviation or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit, and equipment from that specified or indicated on the Drawings, the Contractor shall, with the acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the substitution.

- H. The Engineer shall determine if an "accepted equivalent" to a manufacturer listed in the Specifications is considered acceptable.

1.12 SHOP DRAWINGS

- A. Refer to individual specification sections for additional submittal information.
- B. All plumbing submittals shall be submitted in a single package. "Piece-Meal" or "Partial" submittals will not be accepted, and will be rejected and returned without review, unless prior approval from the Engineer has been obtained. NO EXCEPTIONS.
 - 1. An index shall be provided indicating:
 - a. A complete shop drawing log depicting ALL submittals to be provided for the Division, whether included in the full package or not. Log shall be updated to reflect the submittals provided.
 - b. Specification section.
 - c. Product.
 - d. Plan code.
 - e. Supplier, Manufacturer, Model Number, Contact List, etc.
- C. Plumbing long lead items are excluded from requirement but must be submitted complete in their entirety by specification section, when provided.
- D. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed.
- E. Provide shop drawings for all devices specified under equipment specifications for all systems, materials, equipment, and/or devices. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures) of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one (1) time. No consideration will be given to a partial shop drawing submittal.
 - 1. Equipment shop drawings shall contain full range performance curves, graphs, tables, or other pertinent data which clearly indicates operational range of a given unit size. Computer generated/plotted curves, based solely on design performance, will not be accepted.
 - 2. All specific options and/or alternatives shall be clearly indicated. Failure to do so shall be grounds for rejection.
- F. Submittals shall be marked with the trade involved, i.e., HVAC, plumbing, fire protection, etc. and the specific associated specification section.
- G. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- H. Failure to submit shop drawings in ample time for review shall not entitle the Contractor to an extension of Contract time. No claim for extension by reason of such default will be allowed, nor shall the Contractor be entitled to purchase, furnish, and/or install equipment which has not been reviewed by the Engineer. The Contractor shall incur all costs associated with delay of construction due to equipment and/or materials arriving late due to late or improper shop drawing submittal.

- I. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- J. Acceptance rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not indicate that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.
- K. Acceptance of shop drawings shall not apply to quantity nor relieve Contractor of his responsibility to comply with intent of Drawings and Specifications.
- L. Acceptance of shop drawings is final and no further changes will be allowed without the written consent of the Engineer.
- M. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- N. Conform the plumbing work to the requirements herein. Provide offsets, fittings, drains, and accessories which may be required to accommodate structural, HVAC, plumbing, existing conditions, etc. Investigate the structural and finish conditions affecting the work and arrange the work accordingly. Provide such piping, fittings, valves, and accessories as may be required to meet such conditions.

1.13 CHANGES IN WORK

- A. Change Order is a written order to the Contractor signed by the Owner and the Architect, issued after Contracts have been awarded, authorizing a change in the work or an adjustment in the Contract sum or the Contract time. A Change Order signed by the Contractor indicates his agreement therewith, including the adjustment in the Contract sum or the Contract time.
- B. All changes in the work shall follow the recommendations of the AIA "General Conditions of the Contract for Construction", Article 7.

1.14 MANUFACTURER'S IDENTIFICATION

- A. All component parts of each item of equipment or device shall bear the manufacturer's nameplate giving name of manufacturer, description, size, type, serial and model number, electrical characteristics, etc., in order to facilitate maintenance or replacement. The nameplate of a Contractor or distributor will not be acceptable.
- B. All material and equipment for the electrical portion of the mechanical systems shall bear the label of or be listed by UL, or other accredited authoritative agencies or testing organizations approved by the authority having jurisdiction.

1.15 RECORD DRAWINGS

- A. Refer to Section 017839 "Project Record Documents". Maintain at the job site a record set of Mechanical Drawings on which any changes in location or routing of all equipment, materials and access panels shall be recorded.
- B. At the end of construction, the Contractor shall provide the Owner with a complete set of As-Built Drawings, including all updated coordination drawings, ductwork, and piping plans.

- C. If electronic copies of the contract documents are made available to the Contractor for use in production of As-Built documentation, the Contractor assumes responsibility for completeness and accuracy of the As-Built documents. Translation or manipulation of electronic documents provided to the Contractor is the responsibility of the Contractor.

1.16 MATERIALS AND WORKMANSHIP

- A. All materials and apparatus required for the work, except as otherwise specifically indicated, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected, and finished in every detail and be so selected and arranged as to fit properly into the building spaces. Where no specific type or quality of material is given, a first-class standard article as accepted by industry standards shall be furnished.
- B. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers, and laborers required to unload, transfer, erect, connect, adjust, start, operate, and test each system.
- C. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- D. All labor for installation of mechanical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous, or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.17 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury, or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place, and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Ensure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.18 BASES AND SUPPORTS

- A. Unless otherwise specifically noted, the Contractor shall furnish all necessary supports, rails, framing, bases, and piers required for all equipment furnished under this Division.

- B. Unless otherwise indicated in individual trade Sections, pumps, fans, air handlers, boilers, chillers, tanks, compressors, and other rotating machinery shall be mounted on a minimum of 4-inch-high concrete pads which shall be furnished and installed per the Structural Drawings. All pads shall be extended not less than 4 inches beyond machine base in all directions and sufficient for seismic anchoring with top edge chamfered. Shop drawings of all foundations and pads shall be submitted to the Engineer for review before they are constructed. The Mechanical Contractor shall field coordinate all required dimensional and necessary loading information.
- C. Construction of foundations, supports, pads, bases, and piers where mounted on the floor shall be of the same finish quality as the adjacent and surrounding flooring material.
- D. Unless otherwise shown, all equipment shall be securely attached to the building structure in an acceptable manner. Attachments shall be of a strong and durable nature; any attachments that are insufficient, in the opinion of the Engineer, shall be replaced as directed without extra cost to the Owner.
- E. All equipment supports shall be designed and constructed such that the equipment will be capable of resisting both vertical and horizontal movement. The equipment shall be positively anchored to the bases or supports to resist vertical movement. The equipment and its supports shall be provided with suitable restraints to resist horizontal movement from any direction as dictated by applicable seismic Codes.

1.19 SLEEVES, INSERTS, AND ANCHOR BOLTS

- A. The Contractor shall provide, set in place, and be held responsible for the location of all sleeves, inserts, and anchor bolts required for the work. In the event that failure to do so requires cutting and patching of finished work, it shall be done at the Contractor's expense.
 - 1. It is the responsibility of the Contractor to furnish cast-in-place sleeves, inserts, and anchors in sufficient time to be installed during initial concrete pours. Where job schedules make this impossible, coordinate and obtain acceptance from the Structural Engineer for alternate installation methods.
- B. All pipes and conduits passing through floors, walls or partitions shall be provided with sleeves having an inside diameter 1-inch larger than the outside diameter of the pipe, conduit, or insulation enclosing the pipe.
- C. Penetrations through fire-rated walls, ceilings, and all floors (except slab on grade) in which piping or ducts pass shall be filled solidly with acceptable firestopping material.
- D. When ducts, piping, or conduit penetrate the floor of a mechanical room located above an occupied space, such penetrations shall be made completely watertight, such that a liquid leak shall not pass through the penetration.

1.20 FIRESTOPS AND SEALS

- A. Refer to Section 078413 "Penetration Firestopping" for additional and more specific information and ASTM E 814 and F&T Ratings.
- B. Firestopping systems shall be submitted as shop drawing.
- C. Penetrations through fire-rated walls, ceiling, or floors shall be sealed with a UL approved firestop fitting classified for an hourly rating equivalent to the fire rating of the wall, ceiling, or floor.

- D. Through wall and floor seals shall be used to provide a positive means of sealing pipes or ducts which pass through the concrete foundation of a structure below grade or below ground water level. Seals shall also be used at entry points through concrete walls or floors which must be sealed.
- E. All piping and conduit penetrations through the roof shall be provided with Pate Type PCA pipe curb assemblies or acceptable equivalent. Coordinate installation details with the roofing system being used for the project.

1.21 CUTTING AND PATCHING

- A. Refer to Section 017300 "Execution". The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of work.
- B. Work under this Division shall include furnishing, locating, and setting inserts and/or sleeves required before the floors and walls are built or be responsible for cutting, drilling, or chopping where sleeves and inserts were not installed or correctly located. The Contractor shall do all drilling required for the installation of hangers.
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.

1.22 SCAFFOLDING, RIGGING, HOISTING

- A. The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

1.23 WATERPROOFING

- A. Where any work pierces waterproofing, including waterproof concrete and floors in wet areas, the method of installation shall be reviewed by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking, and flashing required to make openings absolutely watertight.

1.24 ACCESSIBILITY AND ACCESS PANELS

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the work.
- B. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include, but not be limited to motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- C. Access doors in walls, ceilings, floors, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.

- D. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- E. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner.
- F. Permanent ladders for access to equipment when shown on Plans shall be furnished and installed. Coordinate exact requirements in field.

1.25 TEMPORARY OPENINGS

- A. The Contractor shall ascertain from an examination of the Drawings whether any special temporary openings in the building will be required for the admission of apparatus provided under this Division and shall coordinate the requirements accordingly. In the event of failure of the Contractor to give sufficient notice in time to arrange for these openings during construction, the Contractor shall assume all costs of providing such openings thereafter.

1.26 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner's representative.
- B. The Engineer and the Owner shall be notified of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.27 TAGS AND CHARTS

- A. Each valve and piece of apparatus under this Division shall be provided with suitable brass or laminated plastic tags and ceiling tag securely fastened with brass chains, screws, or rivets. Equipment shall be numbered with laminated plastic tags or neatly stenciled letters 2 inches high using designations in equipment schedules and/or shall conform to a directory indicating number, location, and use of each item. Directories shall be prepared under each Section and shall be glass framed.
 - 1. Directory shall indicate valve tag number and the unit number, floor/area branch line, main line, service, or other pertinent data to quickly and easily identify the valve's purpose.

1.28 ESCUTCHEONS

- A. The Contractor shall provide escutcheons on pipes wherever they pass through floors, ceilings, walls, or partitions in finished visible locations. See Section 078413 "Penetration Firestopping" for further requirements.

1.29 PAINTING

- A. All finish painting in completed areas shall be performed per Division 09 of the Specifications.
- B. All materials shipped to the job site under this Division, such as grilles, registers, and/or radiation covers, shall have standard manufacturer's finish, unless otherwise specified.
- C. The Contractor shall paint the interior of all ducts wherever the interior of the duct can be seen through a register or louver. Paint shall be flat black, rust preventative type.
- D. The Contractor shall paint conduits, pipe, and equipment wherever it can be seen through a register or louver. Paint shall not cover-up labels and other identifying items. Paint shall be flat black, rust preventative type.
- E. All uninsulated outdoor piping and fittings shall be properly primed with zinc-rich primer and finished with a minimum of two (2) coats of high-grade exterior enamel.

1.30 PIPE EXPANSION

- A. All pipe connections shall be installed to allow for freedom of movement of the piping during expansion and contraction without springing. Provide engineered design, layout, details, and fabrication, submitted with registered professional engineer sign and seal, of swing joints, expansion loops, and expansion joints with proper anchors and guides. Pay particular attention to plastic piping with high coefficients of expansion.
 - 1. Consideration of required seismic lateral restraints shall be given when anchoring piping and making provision for expansion.

1.31 ELECTRICAL CONNECTIONS

- A. Unless otherwise specified, all wiring shall be furnished and installed per Division 26 Specifications.
- B. The Contractor furnishing equipment shall furnish the motor controller required for the equipment. Provide properly sized overload heaters and all required accessories with all motor controllers. See Division 26 for motor controller requirements.
- C. All power wiring shall be furnished and installed per Division 26 complete from power source to motor or equipment junction box including power wiring through the motor controller and proper means of disconnect per NEC and Division 26. The Division 26 Contractor shall provide all disconnects, unless noted otherwise.

1.32 QUIET OPERATION

- A. Equipment and material used in the various systems described herein shall not produce a sound level greater than 55 decibels in the area served. If noise level is deemed objectionable by the Owner/Engineer, the Contractor shall test and record sound levels in the presence of the Owner/Engineer. The sound level shall be observed on the "A" weighting network of a sound level or sound survey meter. The ASHRAE "Guide and Data Book" provides a means to determine sound level of mechanical equipment when the total of background plus equipment sound levels exceeds the minimum acceptable equipment sound level.
- B. If objectionable noises or vibrations of any magnitude are produced and transmitted to occupied portions of the building by apparatus, piping, ducts, or other parts of the mechanical work, the Contractor shall make such changes or additions as necessary without extra cost to the Owner.

1.33 MAINTENANCE

- A. The Contractor shall provide the necessary skilled labor to assure the proper operation and to provide all required current and preventative maintenance for all equipment and controls provided under this Division until final acceptance of the building by the Owner. The Contractor shall not assume acceptance of the building by the Owner until he receives written notification.
- B. The Contractor shall receive calls for any and all problems experienced in the operation of the equipment provided under this Division and he shall take steps to immediately correct any deficiencies that may exist.
- C. The Contractor shall provide a check list and shall put a copy of it in the boiler or main mechanical room. The check list shall itemize each piece of equipment furnished under his Section.
 - 1. The Contractor shall certify on this check list that he has examined each piece of equipment and that, in his opinion, it is operating as intended by the manufacturer, it has been properly lubricated, and that all necessary current and preventative maintenance has been performed as recommended by the manufacturer and by good and accepted practice.
- D. Where normal preventative maintenance for any piece of equipment requires special tools, the Contractor shall furnish the appropriate tools for that piece of equipment (i.e., special filter removal hooks, valve wrenches, etc.).

1.34 LUBRICATION

- A. All equipment installed under this Contract having moving parts and requiring lubrication shall be properly lubricated according to manufacturer's recommendations prior to testing and operation. Any such equipment discovered to have been operated before lubrication by the Contractor is subject to rejection and replacement at no additional cost to the Owner. Units furnished with sealed bearings are exempted.
- B. The Contractor shall furnish and install, as appropriate on all equipment requiring lubrication, Zerk pressure gun grease fittings or sight gravity-feed oilers equipped with shutoff and needle valve adjustment. Units furnished with sealed bearings and lifetime lubrication are exempted. All fittings and oilers are to be fully accessible for lubrication with equipment which does not require special adapters. Where fittings would be otherwise inaccessible, furnish and install extended grease lines.

1.35 CLEANING

- A. The Contractor shall be responsible for keeping the jobsite clean, safe, and neat throughout the duration of construction. The Contractor shall clean up his own debris daily and shall coordinate removal of rubbish and debris with the General Contractor/Construction Manager.
 - 1. No debris, construction materials, cigarette butts, coffee cups, etc., shall be left above suspended ceilings.
- B. The Contractor shall thoroughly clean and flush all piping and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.
- C. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned, and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions

shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

- D. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to ensure adequate protection against the entrance of foreign matter.
- E. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris, and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

1.36 OPERATING INSTRUCTIONS

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment, and maintenance of all equipment furnished. The Contractor shall give at least 72 hours' notice to the Owner and the Engineer in advance of this period.
- B. The Contractor, in the above-mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this Division.
- C. The appropriate Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
- D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, boilers. These letters will be bound into the operating and maintenance books.
- E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

1.37 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.
- B. Where requested by the Engineer, a factory-trained service engineering representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service engineering representative shall supervise the initial operation of the equipment and instruct the personnel responsible for operation and maintenance of the equipment. The service engineering representative shall notify the Contractor in writing that the equipment was installed according to manufacturer's recommendations and is operating as intended by the manufacturer.

1.38 GUARANTEES

- A. The Contractor shall guarantee all equipment, material, and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner, unless otherwise noted.

- B. During this guarantee period, all defects developing through faulty equipment, materials, or workmanship shall be corrected or replaced immediately by the Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 220100

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and soldered ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.

2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.5 for flanges on steel valves.
 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 5. ASME B16.18 for solder-joint connections.
 6. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than fifteen percent (15%) zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valves in Insulated Piping:
1. Include 2-inch stem extensions.
 2. Extended operating handles of non-thermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRONZE BALL VALVES

- A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Crane; Crane Energy Flow Solutions
 - c. Hammond Valve
 - d. Lance Valves
 - e. Milwaukee Valve Company
 - f. NIBCO INC.
 - g. Watts; a Watts Water Technologies company
 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two-piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless-steel.
 - h. Ball: Stainless-steel, vented.
 - i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.

3.4 VALVE SCHEDULE (150 PSIG OR LESS)

- A. Pipe NPS 2 and Smaller:
 - 1. Refer to Valve Schedule on Drawings.

END OF SECTION 220523.12

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze swing check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than fifteen percent (15%) zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

- a. American Valve, Inc.
- b. Apollo Valves; Conbraco Industries, Inc.
- c. Crane; Crane Energy Flow Solutions
- d. Hammond Valve
- e. Jenkins Valves; Crane Energy Flow Solutions
- f. KITZ Corporation
- g. Macomb Groups (The)
- h. Milwaukee Valve Company
- i. NIBCO INC.
- j. Powell Valves
- k. Red-White Valve Corporation
- l. Stockham; Crane Energy Flow Solutions
- m. Watts; a Watts Water Technologies company

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: Bronze.

B. Bronze Swing Check Valves with Non-metallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Crane; Crane Energy Flow Solutions
 - c. Hammond Valve
 - d. Jenkins Valves; Crane Energy Flow Solutions
 - e. KITZ Corporation
 - f. Milwaukee Valve Company
 - g. NIBCO INC.
 - h. Red-White Valve Corporation
 - i. Stockham; Crane Energy Flow Solutions
 - j. Watts; a Watts Water Technologies company
2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: PTFE.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

- F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

- B. End Connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Refer to Schedules on Drawings.

END OF SECTION 220523.14

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Brady Corporation
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP
 - d. Champion America
 - e. Craftmark Pipe Markers
 - f. Emedco
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.

- j. Seton Identification Products
 - 2. Material and Thickness: Brass, 0.032-inch minimum thickness, and having pre-drilled or stamped holes for attachment hardware.
 - 3. Letter Color: White.
 - 4. Background Color: Black.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.
 - 6. Minimum Letter Size: ¼-inch for name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Brady Corporation
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP
 - d. Champion America
 - e. Craftmark Pipe Markers
 - f. Emedco
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Seton Identification Products
 - 2. Material and Thickness: Multi-layer, multi-color, plastic labels for mechanical engraving, 1/8-inch-thick and having pre-drilled holes for attachment hardware.
 - 3. Letter Color: White.
 - 4. Background Color: Black.
 - 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 6. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.
 - 7. Minimum Letter Size: ¼-inch for name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 8. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8½-by-11-inch bond paper. Tabulate equipment identification number and identify drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Brady Corporation
 - 2. Brimar Industries, Inc.
 - 3. Carlton Industries, LP
 - 4. Champion America
 - 5. Craftmark Pipe Markers
 - 6. emedco
 - 7. LEM Products Inc.
 - 8. Marking Seivics Inc.
 - 9. National Marker Company
 - 10. Seton Identification Products
 - 11. Stranco, Inc.
- B. Material and Thickness: Multi-layer, multi-color, plastic labels for mechanical engraving, 1/8-inch-thick, and having pre-drilled holes for attachment hardware.
- C. Letter Color: Black.
- D. Background Color: Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.
- G. Minimum Letter Size: ¼-inch for name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP
 - 5. Champion America
 - 6. Craftmark Pipe Markers
 - 7. Emedco
 - 8. Kolbi Pipe Marker Co.
 - 9. LEM Products Inc.
 - 10. Marking Seivics Inc.
 - 11. Seton Identification Products

- B. General Requirements for Manufactured Pipe Labels: Pre-printed, color-coded, with lettering indicating service, and showing flow direction.
- C. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 STENCILS

- A. Stencils for Piping:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Brimar Industries, Inc.
 - b. Carlton Industries, LP
 - c. Champion America
 - d. Craftmark Pipe Markers
 - e. Kolbi Pipe Marker Co.
 - f. Marking Services Inc.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.
 - 3. Stencil Material: Fiberboard or metal.
 - 4. Stencil Paint: Exterior, gloss, acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 5. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP
 - 5. Champion America
 - 6. Craftmark Pipe Markers
 - 7. emedco
 - 8. Kolbi Pipe Marker Co.
 - 9. LEM Products Inc.
 - 10. Marking Services Inc.
 - 11. Seton Identification Products

- B. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and ½-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having pre-drilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain or S-hook.
- C. Valve Schedules: For each piping system, on 8½-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Brady Corporation
 - 2. Brimar Industries, Inc.
 - 3. Carlton Industries, LP
 - 4. Champion America
 - 5. Craftmark Pipe Markers
 - 6. Emedco
 - 7. Kolbi Pipe Marker Co.
 - 8. LEM Products Inc.
 - 9. Marking Services Inc.
 - 10. Seton Identification Products
- B. Description: Pre-printed or partially pre-printed accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5¼ inches minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.

- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Division 09.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe Label Color Schedule:
 - 1. Natural Gas Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.
 - 2. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 - 3. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Safety gray.
 - b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 2 inches, round.
 - b. Hot Water: 2 inches, round.
 - c. Natural Gas: 2 inches, round.
 - 2. Valve-Tag Colors:
 - a. Cold Water: Safety green.
 - b. Hot Water: Safety green.
 - c. Natural Gas: Safety yellow.
 - 3. Letter Colors:
 - a. Cold Water: White.
 - b. Hot Water: White.
 - c. Natural Gas: White.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 220553

SECTION 230000 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Basic Mechanical Requirements specifically applicable to Division 23 Sections in addition to Division 01 General Requirements.

1.2 INTENT

- A. It is the intention of the Specifications and Drawings to call for finished work, tested and ready for operation. All materials, equipment, and apparatus shall be new and of first-class quality.
- B. Any apparatus, appliance, material, or work not shown on Drawings, but mentioned in the Specifications, or vice versa, or any incidental accessories or minor details not shown, but necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be provided by the Contractor without additional expense to the Owner.
- C. With submission of bid, the Contractor shall give notice to the Engineer of any materials, apparatus, or omissions believed to be in violation of laws, ordinances, rules or regulations, or authorities having jurisdiction. In the absence of such written notice, it is mutually agreed that the Contractor shall include the cost of providing all systems in accordance with applicable regulations without extra compensation.

1.3 SUBMITTALS

- A. Submit under provisions of Division 01 Sections.
- B. Include products as required by individual Sections.
- C. Submit Shop Drawings and Product Data grouped to include complete submittals of related systems, products, and accessories in a single submittal.
- D. Mark dimensions and values in units to match those specified.
- E. Submit plan indicating measures being taken to maintain indoor air quality of occupied portion of building during construction.

1.4 DRAWINGS AND COORDINATION

- A. Drawings are schematic in nature and do not indicate every item, piece of equipment, and detail. Provide complete operating systems.
- B. Install work as closely as possible to layouts shown on Drawings. Modify work as necessary to meet job conditions and to clear other equipment. Consult Architect before making changes which affect the function or appearance of systems.
- C. Dimensions, elevations, and locations are shown approximately. Verify dimensions in field.

- D. Architect reserves the right to order changes in layout of such items as piping, ducts, and equipment if such changes do not substantially affect costs and if affected items have not been fabricated or installed.
- E. In some cases, Drawings are based on products of one (1) or several manufacturers, as listed on Contract Documents. Contractor shall be responsible for modifications made necessary by substitution of products of other manufacturers. Modifications may be required in electrical distribution materials and components, structural supports, concrete pads, gas piping, breeching and chimneys, etc.
- F. Do not install part of a system until all critical components of the system and related systems have been approved. Coordinate parts of systems.
- G. Coordinate work with work specified in other Sections. Relocate work if required for proper installation and functioning of other systems.
- H. Install products in accordance with manufacturer's instructions. Notify Architect if Contract Documents conflict with manufacturer's instructions. Comply with Architect's interpretations.
- I. Provide brackets, supports, anchors, and frames required for installation of work specified in this division. Such metal work shall conform to the requirements of Section 055000 "Metal Fabrications".
- J. Where Contract Documents provide conflicting information, Contractor shall be responsible for design having highest cost.

1.5 PROJECT RECORD DRAWINGS

- A. Prepare project Record Drawings of mechanical systems in conformance with the requirements of the General Conditions and Division 01 Sections.

1.6 INDOOR AIR QUALITY

- A. Provide measures to maintain minimum standard for indoor air quality in accordance with SMACNA guidelines, by preventing air contaminated by demolition and construction activities from being transferred to occupied portions of building when work includes renovation, addition, or alteration to building occupied during demolition/construction.
- B. Measures shall include but not be limited to the following:
 - 1. Air filtration.
 - 2. Temporarily sealing ductwork, air inlets and outlets, and ventilation openings to prevent transfer of contaminated air.
 - 3. Installation of bypass ducts or openings and additional temporary system modifications as required to prevent cross contamination, and to maintain proper system operation during construction.
- C. Submit plan of cross contamination control measures in accordance with SMACNA guidelines prior to beginning construction.

1.7 PRELIMINARY OPERATION

- A. Operate mechanical systems with required supervision for at least two (2) full days prior to substantial completion. Make necessary adjustments and check proper operation.

1.8 TESTS PRIOR TO SUBSTANTIAL COMPLETION

- A. Tests shall be attended by representatives of mechanical subcontractors, equipped with instruments required to demonstrate proper functioning of systems, as specified. Demonstrate the following:
 - 1. Equipment installed and operating in accordance with the manufacturer's specifications and instructions and with these specifications.
 - 2. Safety and temperature controls operating as specified.
 - 3. Systems properly flushed, cleaned and free of contaminants.
 - 4. Systems properly balanced.
 - 5. Motors equipped with proper overload protection and not operating under overload. Obtain ammeter readings.
 - 6. Instruments recording properly.
 - 7. Submit report listing system tested, date, results and description of fault corrections, if any.

1.9 WARRANTY

- A. Submit written warranty for warranties covering work specified in Division 23. Warranty period shall be one (1) year from the date of Substantial Completion of the building or of the equipment being warranted, whichever is later. Owner is to receive full use of equipment for period of warranty.

1.10 OPERATING AND MAINTENANCE MANUALS

- A. Submit Operating and Maintenance manuals in accordance with this Section and Division 01 Sections.
- B. Include operating and maintenance instructions for equipment where applicable.
- C. List replacement parts and order procedure.
- D. Include lubrication instructions and schedule, with types of lubricant to be used.
- E. Instruct Owner's personnel in use of equipment specified in this Division.

1.11 REGULATORY REQUIREMENTS

- A. Conform to applicable provisions of the Connecticut Basic Building Code which include the following:
 - 1. 2021 Connecticut State Building Code
 - 2. 2021 International Mechanical Code w/Connecticut Amendments
 - 3. 2021 International Plumbing Code w/Connecticut Amendments
 - 4. Amendments, alterations, deletions, and addition of certain provisions to the above as indicated in subsequently issued Supplements.
- B. New construction and renovation work will also conform to applicable provisions of Connecticut Public Health Code.
- C. Indoor air quality during construction will be maintained in accordance with SMACNA IAQ Guidelines for Occupied Buildings under Construction.
- D. New construction and renovation work will also conform to applicable provisions of the Connecticut Fire Safety Code which include the following:

BASIC MECHANICAL REQUIREMENTS

1. Code for Safety to Life from Fire in Buildings, National Fire Protection Association, Inc., Standard 101 (NFPA 101).
 2. Amendments, alterations, deletions, and addition of certain provisions to the above as indicated in the Connecticut Supplement.
- E. Work of this project shall be barrier free and will conform to the Americans with Disabilities Act (ADA), ICC/ANSI 117.1, and Uniform Federal Accessibility Standards (UFAS).
- F. New construction and renovation work will comply with the requirements of the 2021 International Energy Conservation Code for energy efficiency.
- G. Obtain and pay for permits and inspections from authorities having jurisdiction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 230000

SECTION 230100 - MECHANICAL DEMOLITION

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. Demolition involving mechanical systems as described in Contract Documents.

1.3 SCHEDULING

- A. Include on Construction Schedule sequence of individual electrical demolition operations.
- B. Coordinate with Owner for equipment and materials to be removed by Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. All relocations, reconnections, and removals are not necessarily indicated on Drawings. All such work shall be included without additional cost to Owner. The Contractor shall visit the site prior to submitting his proposal and familiarize himself with the complete extent of the demolition and removal of work.

3.2 PREPARATION

- A. Disconnect equipment that is to be removed or relocated. Carefully remove, disassemble, or dismantle as required, and store in approved location on site, existing items to be reused in completed work.
- B. Verify electrical power secured off at panel prior to commencing demolition of electrically powered equipment.
- C. Where affected by demolition or new construction, relocate, extend, or repair ductwork and piping to allow continued use of mechanical systems. Use methods and materials as specified for new construction.
- D. Mechanical contractor shall be responsible for cutting, capping, and repairing mechanical systems. Mechanical contractor shall cut and make safe all systems being modified or removed. Demolition contractor shall remove and dispose of systems.
- E. Systems designated for removal shall be removed in their entirety, including but not limited to, all ductwork, piping, hangers, supports, controls, and wiring.

3.3 PERFORMANCE

- A. Perform drilling, cutting, block-offs, and demolition work required for removal of necessary portions of electrical system. Do not cut joists, beams, girders, trusses, or columns without prior written permission from Architect.
- B. Patch, repair, and finish surfaces affected by mechanical demolition work, unless work is specifically called for under other Sections of the specifications.
- C. Remove electrical disconnect switches and control panels serving mechanical equipment being removed. Remove conductors back to panel. Coordinate removal of electrical devices with electrical contractor.
- D. All equipment and materials designated for removal shall be removed from site and disposed of in a legal manner.

3.4 ASBESTOS AND HAZARDOUS MATERIALS

- A. If asbestos, PCBs, or other hazardous materials are encountered in the course of work, stop work in the vicinity of such materials and report their presence to the Owner. Owner will arrange for proper removal and disposal of hazardous materials.

3.5 CLEANING

- A. Remove obsolete equipment, piping, hangers, supports, and miscellaneous promptly from site and dispose of legally.

END OF SECTION 230100

SECTION 230130.51 - HVAC AIR-DISTRIBUTION SYSTEM CLEANING

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 cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

1.3 DEFINITIONS

- A. ASCS: Air systems cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For an ASCS.
- B. Strategies and procedures plan.
- C. Cleanliness verification report.

1.5 QUALITY ASSURANCE

- A. ASCS Qualifications: A certified member of NADCA.
 - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
 - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.
- C. Cleaning Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
- C. Prepare written report listing conditions detrimental to performance of the Work.
- D. Proceed with work only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
 - 1. Supervisor contact information.
 - 2. Work schedule including location, times, and impact on occupied areas.
 - 3. Methods and materials planned for each HVAC component type.
 - 4. Required support from other trades.
 - 5. Equipment and material storage requirements.
 - 6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.3 CLEANING

- A. Clean all supply, return, exhaust and outside air ductwork associated with work of this project.
- B. Comply with NADCA ACR 2006.
- C. Remove visible surface contaminants and deposits from within the HVAC system.
- D. Systems and Components to Be Cleaned:
 - 1. Air devices for supply and return air.
 - 2. Air-terminal units.
 - 3. Ductwork:
 - a. Supply-air ducts, including turning vanes, to the air-handling unit.
 - b. Return-air ducts to the air-handling unit.
 - c. Exhaust-air ducts.
 - d. Outside air intake ducts.
 - 4. Air-Handling Units:
 - a. Interior surfaces of the unit casing.
 - b. Coil surfaces compartment.
 - c. Condensate drain pans.
 - d. Fans, fan blades, and fan housings.
 - 5. Exhaust Fans:
 - a. Interior surfaces of the unit casing.
 - b. Roof curbs.
 - c. Associated louvers.

- d. Fan, fan blades, and fan housings.
- 6. Filters and filter housings.
- E. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- F. Particulate Collection:
 - 1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
 - 2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- G. Control odors and mist vapors during the cleaning and restoration process.
- H. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- I. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
- J. Clean all air-distribution devices, registers, grilles, and diffusers.
- K. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:
 - 1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
 - 2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
 - 3. Clean evaporator coils, reheat coils, and other airstream components.
- L. Duct Systems:
 - 1. Create service openings in the HVAC system as necessary to accommodate cleaning.
 - 2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
- M. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
- N. Mechanical Cleaning Methodology:
 - 1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
 - a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.

- b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.
 - 2. Cleaning Mineral-Fiber Insulation Components:
 - a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
 - b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
 - c. Fibrous materials that become wet shall be discarded and replaced.
- O. Coil Cleaning:
 - 1. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
 - 2. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
 - 3. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
 - 4. Rinse thoroughly with clean water to remove any latent residues.
- P. Anti-microbial Agents and Coatings:
 - 1. Apply anti-microbial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply anti-microbial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
 - 2. When used, anti-microbial treatments and coatings shall be applied after the system is rendered clean.
 - 3. Apply anti-microbial agents and coatings directly onto surfaces of interior ductwork.
 - 4. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

3.4 CLEANLINESS VERIFICATION

- A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.
- B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

D. Additional Verification:

1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for non-porous surfaces.

E. Verification of Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. Coil will be considered clean if cleaning restored the coil static-pressure differential within ten percent (10%) of the differential measured when the coil was first installed.
3. Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

F. Prepare a written cleanliness verification report. At a minimum, include the following:

1. Written documentation of the success of the cleaning.
2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
3. Surface comparison test results if required.
4. Gravimetric analysis (non-porous surfaces only).
5. System areas found to be damaged.

G. Photographic Documentation: Provide photographic evidence of coils, ducts, and grilles being cleaned.

3.5 RESTORATION

- A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening. Include location of service openings in Project closeout report.
- C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233113 "Metal Ducts".
- D. Replace damaged insulation according to Section 230700 "HVAC Insulation."
- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

END OF SECTION 230130.51

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multi-speed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multi-speed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, anti-friction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multi-speed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics and features coordinated with and approved by controller manufacturer.
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multi-speed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, anti-friction ball bearings or sleeve bearings suitable for radial and thrust loading.

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- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Used)

END OF SECTION 230513

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal-bellows expansion joints.
 - 2. Expansion compensators.
 - 3. Rubber expansion joints.
 - 4. Flexible-hose expansion joints.
 - 5. Slip expansion joints.
 - 6. Guides and anchors.
 - 7. Pipe bends and loops.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of fitting indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: For thermal expansion of piping systems and selection and design of expansion fittings and loops.
 - 2. Anchor Details: Detail fabrication of each indicated. Show dimensions and methods of assembly.
 - 3. Alignment Guide Details: Detail field assembly and anchorage.
- C. Welding certificates.
- D. Expansion Joint and Loop Schedule: Indicate manufacturer's number, size, location, and features for each expansion fitting and loop.

1.4 QUALITY ASSURANCE

- A. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for expansion fittings and loops by a qualified professional engineer.
 - 1. Professional Engineer Qualifications: Legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services indicated.
- B. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

- A. Metal-Bellows Expansion Joints: 175-psig minimum pressure rating, with end fittings and external tie rods for limiting maximum travel, and flanged-end connections, unless otherwise indicated.
1. Manufacturers:
 - a. Adsko Manufacturing Corp.
 - b. Anamet, Inc.
 - c. Badger Industries, Inc.
 - d. Expansion Joint Systems, Inc.
 - e. Flexicraft Industries
 - f. Flex-Weld, Inc.
 - g. Hyspan Precision Products, Inc.
 - h. Metraflex Co.
 - i. Pathway Bellows, Inc.
 - j. Piping Technology & Products, Inc.
 - k. Proco Products, Inc.
 - l. Senior Flexonics, Inc.; Expansion Joint Div.
 - m. Wahlco Engineered Products, Inc.
 2. Configuration: Double-bellows type, with base.
 3. Joints for Copper Piping: Two-ply, phosphor-bronze bellows and brass shroud.
 4. Joints for Steel Piping: Two-ply, stainless-steel bellows and carbon-steel shroud.
- B. Expansion Compensators: 175-psig minimum pressure rating, with internal guides, anti-torque device, and removable end clip for positioning.
1. Manufacturers:
 - a. Adsko Manufacturing Corp.
 - b. Flexicraft Industries
 - c. Flex-Weld, Inc.
 - d. Hyspan Precision Products, Inc.
 - e. Metraflex Co.
 - f. Senior Flexonics, Inc.; Expansion Joint Div.
 2. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
 3. End Connections for NPS 2-1/2 and Larger: Flanged.
 4. Joints for Copper Piping: Two-ply, phosphor-bronze bellows and brass shroud.
- C. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced butyl rubber, and pressure rated for 175 psig at 240 deg F minimum.
1. Manufacturers:
 - a. Flexicraft Industries
 - b. Flex-Weld, Inc.
 - c. Garlock, Inc.
 - d. General Rubber Corp.
 - e. Mercer Rubber Co.
 - f. Metraflex Co.

- g. MG Piping Products Co.
 - h. Proco Products, Inc.
 - i. Senior Flexonics, Inc.; Expansion Joint Div.
 - j. Vibration Mountings & Controls, Inc.
 - 2. Configuration: Full-faced, integral, steel-flanged-end connections; external control rods; and steel retaining rings drilled to match flange bolt holes.
 - 3. Type: Double sphere.
- D. Flexible-Hose Expansion Joints: Manufactured assembly with two (2) flexible-metal-hose legs joined by long-radius 180-degree return bend with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.
 - 1. Manufacturers:
 - a. Flexicraft Industries
 - b. Metraflex Co.
 - 2. Joints for Copper Piping: Copper fittings with solder-joint end connections.
 - a. NPS 2 and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F minimum pressure ratings.
 - b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F minimum pressure ratings.
 - 3. Joints for Steel Piping: Carbon-steel fittings.
 - a. End Connections for NPS 2 and Smaller: Threaded.
 - b. End Connections for NPS 2-1/2 and Larger: Flanged.
 - c. Joints for NPS 2 and Smaller: Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F minimum pressure ratings.
 - d. Joints for NPS 2-1/2 to NPS 6: Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F minimum pressure ratings.
- E. Slip Expansion Joints: Carbon-steel, packing-type pipe expansion joint designed for repacking under pressure and pressure rated for 250 psig at 400 deg F minimum with compound limit stops, asbestos-free polytetrafluoroethylene packing, flanged or weld ends to match piping system, drip connection if used for steam piping systems, and flanged-end connections.
 - 1. Manufacturers:
 - a. Adscro Manufacturing Corp.
 - b. Advanced Thermal Systems, Inc.
 - c. Hyspan Precision Products, Inc.
 - 2. Single-Slip Type: With base, if indicated.
 - 3. Double-Slip Type: With base.

2.2 MISCELLANEOUS MATERIALS

- A. Guides: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

- B. Structural Steel: ASTM A 36.
- C. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
- D. Washers: ASTM F 844, steel, plain, flat washers.
- E. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application.
 - 1. Stud: Threaded, zinc-coated carbon steel.
 - 2. Expansion Plug: Zinc-coated steel.
 - 3. Washer and Nut: Zinc-coated steel.
- F. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened Portland cement concrete, and tension and shear capacities appropriate for application.
 - 1. Bonding Material: ASTM C 881, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - 2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - 3. Washer and Nut: Zinc-coated steel.
- G. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged non-shrink and non-metallic grout; suitable for interior and exterior applications.
 - 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout.
 - 2. Properties: Non-staining, non-corrosive, and non-gaseous.
 - 3. Design Mix: 5000-psi, twenty-eight (28) day compressive strength.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install expansion fittings in sizes matching pipe size in which they are installed. Align to avoid end-loading and torsional stress.
- B. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- C. Attach pipe bends and loops to anchors.
 - 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.
- D. Connect risers and branch connections to mains with at least five (5) pipe fittings, including tee in main.
- E. Connect risers and branch connections to terminal units with at least four (4) pipe fittings, including tee in riser.
- F. Connect mains and branch connections to terminal units with at least four (4) pipe fittings, including tee in main.

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- G. Install guides on piping adjoining expansion fittings and loops. Attach guides to pipe, and secure to building structure.
- H. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- I. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1.
- J. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
- K. Install pipe anchors according to expansion fitting manufacturer's written instructions if expansion fittings are indicated.
- L. Use grout to form flat bearing surfaces for expansion fittings, guides and anchors installed on or in concrete.
- M. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- N. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230516

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

- A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless-steel.
 - 3. Connecting Bolts and Nuts: Stainless-steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

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

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above Grade:

- a. Piping Smaller Than NPS 6: Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves.
- 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
- 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
- b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
- f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
- g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

2. Escutcheons for Existing Piping:

- a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
- b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated rough-brass finish.
- f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated rough-brass finish.

- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bi-metallic-actuated thermometers.
 - 2. Filled-system thermometers.
 - 3. Liquid-in-glass thermometers.
 - 4. Thermowells.
 - 5. Dial-type pressure gages.
 - 6. Gage attachments.
 - 7. Test plugs.
 - 8. Test-plug kits.
 - 9. Sight flow indicators.
 - 10. Insertion Electromagnetic flowmeters
 - 11. Ultrasonic thermal energy meters

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BI-METALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Ashcroft Inc.
 - 2. Ernst Flow Industries
 - 3. Miljoco Corporation
 - 4. Palmer Wahl Instrumentation Group
 - 5. Terice, H. O. Co.

- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type; stainless-steel with 5-inch nominal diameter.
- D. Dial: Non-reflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- F. Connector Size: ½-inch, with ASME B1.1 screw threads.
- G. Stem: 0.375-inch in diameter; stainless-steel.
- H. Window: Plain glass.
- I. Ring: Stainless-steel.
- J. Element: Bi-metal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus one percent (+/-1%) of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Ashcroft Inc.
 - b. Miljoco Corporation
 - c. Palmer Wahl Instrumentation Group
 - d. Terice, H. O. Co.
 - e. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum, 5-inch nominal diameter.
4. Element: Bourdon tube.
5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
6. Dial: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless-steel.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus one and one-half percent (+/-1.5%) of scale range.

B. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Ashcroft Inc.
 - b. Miljoco Corporation
 - c. Terice, H. O. Co.
 - d. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum 5-inch nominal diameter with back flange and holes for panel mounting.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless-steel.
10. Connector Type(s): Union joint, bottom; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus one and one-half percent (+/-1.5%) of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit
 - b. Ernst Gage Co.
 - c. Terice, H. O. Co.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Straight unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
9. Connector: 3/4-inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus one percent (+/-1%) of scale range or one (1) scale division, to a maximum of one and one-half percent (1.5%) of scale range.

B. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Flo Fab Inc.
 - b. Miljoco Corporation
 - c. Palmer Wahl Instrumentation Group
 - d. Terice, H. O. Co.
 - e. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
9. Connector: 1¼ inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus one percent (+/-1%) of scale range or one (1) scale division, to a maximum of one and one-half percent (1.5%) of scale range.

2.4 DUCT-THERMOMETER MOUNTING BRACKETS

- A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.5 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Stainless-steel.
4. Material for Use with Steel Piping: Stainless-steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: ½-, ¾-, and 1-inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

2.6 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Ashcroft, Inc.
 - b. Ernst Flow Industries
 - c. Palmer Wahl Instrumentation Group
 - d. Terice, H. O. Co.
2. Standard: ASME B40.100.
3. Case: Liquid-filled cast aluminum; 4½-inch.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless-steel.
11. Accuracy: Grade A, plus or minus one percent (+/-1%) of middle half of scale range.

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products or comparable product by one (1) of the following:
 - a. AMETEK, Inc.; U.S. Gauge
 - b. Ashcroft, Inc.
 - c. Ernst Flow Industries
 - d. Palmer Wahl Instrumentation Group
 - e. Terice, H. O. Co.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type; cast aluminum; 4½-inch nominal diameter with back flange and holes for panel mounting.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless-steel.
11. Accuracy: Grade A, plus or minus one percent (+/-1%) of middle half of scale range.

2.7 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8) ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 (DN 8) pipe threads.
- C. Valves: Brass ball with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

2.8 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Flow Design, Inc.
 - 2. Miljoco Corporation
 - 3. Trerice, H. O. Co.
 - 4. Peterson Equipment Co., Inc.
 - 5. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 (DN 8), ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: EPDM self-sealing rubber.

2.9 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Flow Design, Inc.
 - 2. Miljoco Corporation
 - 3. Trerice, H. O. Co.
 - 4. Peterson Equipment Co., Inc.
 - 5. Weiss Instruments, Inc.
- B. Furnish one (1) test-plug kit containing two (2) thermometers, one (1) pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 100 deg F.
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

2.10 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products or comparable product by one (1) of the following:
 - 1. Archon Industries, Inc.
 - 2. Dwyer Instruments, Inc.

3. Emerson Process Management; Brooks Instrument
4. Ernst Flow Industries
5. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH

- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 150 psig.
- E. Minimum Temperature Rating: 200 deg F.
- F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

2.11 FLOWMETERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide following:
 1. Onicon Incorporated
- B. Provide an ONICON **Model F-3500** Insertion Electromagnetic Flow Meter, complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand-insertable up to 400 psi. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall average velocity readings from two (2) sets of diametrically opposed electrodes. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within plus or minus one percent ($\pm 1\%$) of rate from 2-20 ft/s. Overall turndown shall exceed 80:1. Output signals shall be completely isolated and shall consist of the following: (1) high resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter, (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable, and (1) scalable dry contact output for totalization. Each flow meter shall be covered by the manufacturer's two-year warranty.
- C. Optional Flow Display: Provide a **D-1200 Series** Display Module for local or remote indication of flow rate and/or total.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.

- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel.
- J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- K. Install test plugs in piping tees.
- L. Install flow indicators in piping systems in accessible positions for easy viewing.
- M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- N. Install flowmeter elements in accessible positions in piping systems.
- O. Install wafer-orifice flowmeter elements between pipe flanges.
- P. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- Q. Install permanent indicators on walls or brackets in accessible and readable positions.
- R. Install connection fittings in accessible locations for attachment to portable indicators.
- S. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- T. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Inlet and outlet of each hydronic coil in air-handling units.
 - 4. Inlet and outlet of each hydronic pump.
 - 5. Inlet and outlet of each thermal-storage tank.
 - 6. Outside-, return-, supply-, and mixed-air ducts.
- U. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each hot water connection.
 - 3. Suction and discharge of each pump.
- V. Install pressure/temperature ports in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Inlet and outlet of each hydronic coil in air-handling units.
 - 4. Inlet and outlet of each hydronic pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone shall be one (1) of the following:
 - 1. Liquid-filled and sealed bi-metallic-actuated type.
 - 2. Direct-or mounted, metal-case, vapor-actuated type.
 - 3. Compact or Industrial-style, liquid-in-glass type.
 - 4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each hydronic boiler shall be one (1) of the following:
 - 1. Liquid-filled and sealed bi-metallic-actuated type.
 - 2. Direct-or mounted, metal-case, vapor-actuated type.
 - 3. Compact or Industrial-style, liquid-in-glass type.
 - 4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
- C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one (1) of the following:
 - 1. Liquid-filled and sealed bi-metallic-actuated type.
 - 2. Direct-or mounted, metal-case, vapor-actuated type.
 - 3. Compact or Industrial-style, liquid-in-glass type.
 - 4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
- D. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one (1) of the following:
 - 1. Liquid-filled and sealed bi-metallic-actuated type.
 - 2. Direct-or mounted, metal-case, vapor-actuated type.
 - 3. Compact or Industrial-style, liquid-in-glass type.
 - 4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
- E. Thermometers at inlet and outlet of each thermal-storage tank shall be one (1) of the following:
 - 1. Liquid-filled and sealed bi-metallic-actuated type.
 - 2. Direct-or mounted, metal-case, vapor-actuated type.
 - 3. Compact or Industrial-style, liquid-in-glass type.
 - 4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

- F. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one (1) of the following:
 - 1. Liquid-filled and sealed bi-metallic-actuated type.
 - 2. Direct-or mounted, metal-case, vapor-actuated type.
 - 3. Compact or Industrial-style, liquid-in-glass type.
- G. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F.
- B. Scale Range for Air Ducts: 0 to 150 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be one (1) of the following:
 - 1. Sealed direct-mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- B. Pressure gages at inlet and outlet of each hot water connection shall be one (1) of the following:
 - 1. Sealed direct mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- C. Pressure gages at suction and discharge of each pump shall be one (1) of the following:
 - 1. Sealed direct mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for heating hot water Piping: 0 to 160 psi.

3.8 FLOWMETER SCHEDULE

- A. Flowmeters for heating hot water Piping: Insertion Electromagnetic type.

3.9 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters for Heating, Hot-Water Piping: Ultrasonic type.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze angle valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron, center-guided check valves.
7. Bronze gate valves.
8. Iron gate valves.
9. Bronze globe valves. Iron globe valves.
10. Iron globe valves.
11. Chainwheels.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Non-rising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves and for butterfly valves mounted 96 inches AFF or higher.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
4. Chainwheel: Device for attachment to valve handwheel, stem, or gear actuator or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

A. Class 150, Bronze Angle Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide product by one (1) of the following:
 - a. Crane Co.; Crane Valve Group; Stockham Division
 - b. Kitz Corporation
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves
 - c. Crane Co.; Crane Valve Group; Crane Valves
 - d. Hammond Valve
 - e. Milwaukee Valve Company
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two-piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves
 - c. Hammond Valve
 - d. Kitz Corporation
 - e. Milwaukee Valve Company
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bi-directional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless-steel.
 - g. Disc: Stainless-steel.

2.5 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves
 - c. Milwaukee Valve Company
 - d. Hammond Valve
 - e. Kitz Corporation
2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.6 IRON SWING CHECK VALVES

A. Class 250, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products or comparable product by one (1) of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves

- b. Hammond Valve
- c. Milwaukee Valve Company

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.
- h. Style: Compact wafer.
- i. Seat: EPDM.

2.7 IRON, CENTER-GUIDED CHECK VALVES

A. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. APCO Willamette Valve and Primer Corporation
 - b. Crispin Valve
 - c. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig.
 - d. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - e. Style: Compact wafer, spring loaded
 - f. Seat: Bronze.

2.8 BRONZE GATE VALVES

A. Class 150, RS Bronze Gate Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves
 - b. Hammond Valve
 - c. Milwaukee Valve Company
 - d. Hammond Valve
 - e. Kitz Corporation
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.

- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

2.9 IRON GATE VALVES

A. Class 250, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves
 - b. Crane Co.; Crane Valve Group; Stockham Division
 - c. Hammond Valve
 - d. Milwaukee Valve Company
 - e. NIBCO INC.
 - f. Powell Valves
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.

2.10 BRONZE GLOBE VALVES

A. Class 150, Bronze Globe Valves with Non-metallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves
 - b. Hammond Valve
 - c. Milwaukee Valve Company
 - d. Kitz Corporation
 - e. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze.

2.11 IRON GLOBE VALVES

A. Class 250, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves
 - b. Crane Co.; Crane Valve Group; Jenkins Valves
 - c. Crane Co.; Crane Valve Group; Stockham Division
 - d. Hammond Valve
 - e. Milwaukee Valve Company
 - f. NIBCO INC.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.

2.12 CHAINWHEELS

- ### A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Babbitt Steam Specialty Co.
 2. Roto Hammer Industries
 3. Trumbull Industries
- ### B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheel directly to handwheels.
1. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve. Include zinc coating.
 2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.

- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for ball, butterfly, butterfly, gate, and globe valves, NPS 4 (DN 100) and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or ball valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service except Steam: Globe valves.
 - 4. Pump-Discharge Check Valves:
 - a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends.
 - 3. For Steel Piping NPS 5 (DN125) and Larger: Flanged ends.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze disc.
3. Ball Valves: Two-piece, full port, bronze with bronze trim.
4. Bronze Swing Check Valves: Class 150, bronze disc.
5. Bronze Gate Valves: Class 150, RS.
6. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Butterfly Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150, flange ends.
2. Iron Compact Wafer, center guided check Valves: Class 250
Iron Swing Check Valves: Class 250, metal seats.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Fastener systems.
5. Pipe stands.
6. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications".
2. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
3. Section 233113 "Metal Ducts".

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
 3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
- B. Copper Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Unistrut Corporation or comparable product by one (1) of the following:
 - a. Allied Tube & Conduit
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation
 - f. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Unistrut Corporation or comparable product by one (1) of the following:
 - a. Anvil International; a subsidiary of Mueller Water Products Inc.
 - b. Empire Industries, Inc.
 - c. ERICO International Corporation
 - d. Haydon Corporation; H-Strut Division
 - e. NIBCO INC.
 - f. PHD Manufacturing, Inc.
 - g. PHS Industries, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide product by one (1) of the following:
1. Carpenter & Paterson, Inc.
 2. Clement Support Services
 3. ERICO International Corporation
 4. National Pipe Hanger Corporation
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One (1) or more; plastic.
 - 3. Vertical Members: Two (2) or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- E. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36, carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 inches and larger and at changes in direction of piping.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- N. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048-inch-thick.
 - b. NPS 4 (DN 100): 12 inches long and 0.06-inch-thick.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 PIPE HANGERS AND SUPPORT SPACING

- A. Support horizontal steel and copper as follows:
 - 1. ½- to 1¼-Inch Pipe Size: 6'-0" maximum hanger spacing.
 - 2. 1½- to 2-Inch Pipe Size: 10'-0" maximum hanger spacing.
 - 3. 2½- to 3-Inch Pipe Size: 10'-0" maximum hanger spacing.
 - 4. 4- to 6-Inch Pipe Size: 10'-0" maximum hanger spacing.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to ½ inch beyond nut.

3.6 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use non-metallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 2. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 3. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

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4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 5. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 3. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one (1) of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 3. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1¼ inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Pre-set to indicated load and limit variability factor to twenty-five percent (25%) to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Pre-set to indicated load and limit variability factor to twenty-five percent (25%) to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Pre-set to indicated load and limit variability factor to twenty-five percent (25%) to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two (2) vertical-type supports and one (1) trapeze member.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Restrained spring isolators.
 - 5. Housed spring mounts.
 - 6. Elastomeric hangers.
 - 7. Spring hangers with vertical-limit stops.
 - 8. Pipe riser resilient supports.
 - 9. Resilient pipe guides.
 - 10. Restrained vibration isolation roof-curbs.
 - 11. Seismic snubbers.
 - 12. Restraining braces and cables.
 - 13. Steel vibration isolation equipment bases.
 - 14. Restrained isolation roof curb rails.

1.3 DEFINITIONS

- A. 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. Provide wind and seismic restraints in accordance with the requirements of the Connecticut State Building Code.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
- B. Delegated-Design Submittal: For vibration isolation and 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 and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
 4. Seismic and Wind-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic and wind 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. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
- C. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- D. Welding certificates.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For professional engineer and 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, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approval OPA number from OSHPD, pre-approval by ICC-ES, or pre-approval 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 pre-approved 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.

PART 2 - PRODUCTS

2.1 ISOLATION PADS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Cambridge
 - 2. Kinetics Noise Control
 - 3. Mason Industries
 - 4. Vibro-Acoustics
- B. Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
- C. Size: Factory or field cut to match requirements of supported equipment.
 - 1. Pad Material: Oil and water resistant with elastomeric properties.
 - 2. Surface Pattern: Waffle pattern.
 - 3. Infused non-woven cotton or synthetic fibers.
 - 4. Load-bearing metal plates adhered to pads.
 - 5. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Waffle pattern.
 - b. Infused non-woven cotton or synthetic fibers.
 - 6. Resilient Material: Oil- and water-resistant neoprene.

2.2 ELASTOMERIC ISOLATION MOUNTS (DOUBLE DEFLECTION)

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Cambridge
 - 2. Kinetics Noise Control
 - 3. Mason Industries
 - 4. Vibration Eliminator Co., Inc.
 - 5. Vibration Isolation
 - 6. Vibro-Acoustics
- B. Mounting Plates:

1. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
2. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

C. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cambridge
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation
6. Vibro-Acoustics

B. Description: All-directional isolator with restraints containing two (2) separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

1. Housing: Cast-ductile iron or welded steel.
2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED SPRING ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cambridge
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation
6. Vibro-Acoustics

B. Description: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to ¼ inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and internal leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
4. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
5. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
6. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.

2.5 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Cambridge
 2. Kinetics Noise Control
 3. Mason Industries
 4. Vibration Eliminator Co., Inc.
 5. Vibration Isolation
 6. Vibro-Acoustics
- B. Description:
1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 2. Outside Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
 4. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
 5. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.

2.6 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two (2) steel tubes separated by a minimum of ½-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

2.7 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two (2) steel tubes or post and sleeve arrangement separated by a minimum of ½-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.8 SPRING HANGERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Kinetics Noise Control
 2. Mason Industries
 3. Vibration Eliminator Co., Inc.
 4. Vibration Isolation
 5. Vibro-Acoustics

- B. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
 4. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
 5. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.9 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Cambridge
 2. Kinetics Noise Control
 3. Mason Industries
 4. Vibration Eliminator Co., Inc.
 5. Vibration Isolation
 6. Vibro-Acoustics
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36. Rails shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

- D. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.10 RESTRAINED VIBRATION ISOLATION ROOF CURBS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Isolaton Technology, Inc.
 - 2. Kinetics Noise Control
 - 3. Mason Industries
 - 4. Thybar Corporation
 - 5. Vibration Eliminator Co., Inc.
 - 6. Vibration Isolation
- B. General Requirements for Restrained Vibration Isolation Roof-Curb: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Lower Support Assembly: Formed sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
- D. The curb shall be built to seismically contain the roof top unit. The unit must be solidly fastened to the top floating rail and the lower section anchored to the roof structure.
- E. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on ¼-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
 - 1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic and wind restraint.
 - a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.

- b. Outside Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
 - d. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
 - e. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.
- 2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - a. Resilient Material: Oil- and water-resistant natural rubber.
- F. Snubber Bushings: All-directional, elastomeric snubber bushings at least ¼ inches thick.
- G. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.
- H. Acoustic Barrier Package: The package shall consist of high transmission loss 2-inch-thick panel assembly. The panel shall be constructed of two (2) sheets of 16-gauge galvanized steel, filled with insulation, 2-inch-thick, 1.25 lbs./cu. ft. minimum density.

2.11 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries
 - 2. Hilti, Inc.
 - 3. Kinetics Noise Control
 - 4. Loos & Co.; Cableware Division
 - 5. Mason Industries
 - 6. TOLCO Incorporated; a brand of NIBCO INC.
 - 7. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications 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 (4) times the maximum seismic forces to which they will be subjected.
- C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 - 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 - 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 - 3. Maximum ¼-inch air gap, and minimum ¼-inch-thick resilient cushion.
- D. 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.

- E. Restraint Cables: ASTM A 603 galvanized steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two (2) clamping bolts for cable engagement.
- F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- H. 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 used.
- I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in 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. Minimum length of eight (8) times diameter.
- K. Adhesive Anchor Bolts: 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.

2.12 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanized 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- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind 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. 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.
- B. 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 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125-inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- D. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. 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.
- I. 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.
- J. 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 pre-stressed 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 VIBRATION ISOLATION AND SEISMIC RESTRAINT OF DUCTWORK

A. Vibration Isolation of Ductwork:

1. All discharge runs for a distance of 50 feet from the connected equipment shall be isolated from the building structure by means of specification 10 hangers or specification 5 floor isolators. Spring deflection shall be a minimum of 0.75-inch.
2. All duct runs having air velocity of 1000 fpm or more shall be isolated from the building structure by specification 11 hangers or 5 floor supports. Spring deflection shall be a minimum of 0.75-inch.

B. Seismic Restraint of Ductwork:

1. Restrain rectangular ducts with cross sectional area of 6 sq. ft. or larger.
2. Restrain round ducts with diameters of 28 inches or larger.
3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
4. Transverse restraints shall occur at 30-foot intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
5. Longitudinal restraints shall occur at 60-foot intervals with at least one (1) restraint per duct run. Transverse restraints for one (1) duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4 feet of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
6. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
7. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
8. Walls, including gypsum board non-bearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
9. Connection to the structure must be made with a non-friction connection.

C. Ductwork Exclusions:

1. Rectangular and square and ducts that are less than 6 square feet in cross sectional area.
2. All trapezed ductwork where the distance from the suspension point to the trapeze member is 12 inches or less.

3. Ductwork hung with straps where the top of the duct is 12 inches or less from the suspension point and the strap has two (2) #10 sheet metal screws within 2 inches of the top of the duct.
4. If any suspension location in the run exceeds the above, the entire run must be braced.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. 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 post connection testing has been approved), and with at least seven (7) days advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four (4) of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to ninety percent (90%) of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Adjust isolators after piping system 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 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having pre-drilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.
 3. Minimum Letter Size: ¼-inch for name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 4. Fasteners: Stainless-steel rivets.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8½-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multi-layer, multi-color, plastic labels for mechanical engraving, 1/8-thick, and having pre-drilled holes for attachment hardware.
- B. Letter Color: Red.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.
- F. Minimum Letter Size: ¼-inch name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Pre-printed, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1½ inches high.

2.4 DUCT LABELS

- A. Material and Thickness: Multi-layer, multi-color, plastic labels for mechanical engraving, 1/16-inch-thick, and having pre-drilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.
- F. Minimum Letter Size: ¼-inch for name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 2. Lettering Size: At least 1½ inches high.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and ½-inch numbers.
 1. Tag Material: Brass, 0.032-inch minimum thickness, and having pre-drilled or stamped holes for attachment hardware.
 2. Fasteners: Brass beaded chain or S-hook.
- B. Valve Schedules: For each piping system, on 8½-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Pre-printed or partially pre-printed, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5¼ inches minimum.
 2. Fasteners: Brass grommet and chain.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 10 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.3 DUCT LABEL INSTALLATION

- A. Install plastic-laminated self-adhesive duct labels with permanent adhesive on air ducts.
- B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1-inch high is needed for proper identification because of distance from normal location of required identification.
- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 10 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.4 VALVE-TAG INSTALLATION

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

1. Valve-Tag Size and Shape:
 - a. Refrigerant: 2 inches, round.
 - b. Gas: 2 inches, round.
2. Valve-Tag Colors:
 - a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
 - b. Flammable Fluids: Black letters on a safety-yellow background.
 - c. Combustible Fluids: White letters on a safety-brown background.
 - d. Potable and Other Water: White letters on a safety-green background.
 - e. Compressed Air: White letters on a safety-blue background.
 - f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Testing, Adjusting, and Balancing of Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - c. Multi-zone systems.
 - 2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary-secondary hydronic systems.
 - 3. Testing, adjusting, and balancing of equipment.
 - 4. Sound tests.
 - 5. Vibration tests.
 - 6. Duct leakage tests verification.
 - 7. Pipe leakage tests verification.
 - 8. UFAD plenum leakage tests verification.
 - 9. HVAC-control system verification.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.
- G. UFAD: Underfloor air distribution.

1.4 PRE-INSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of fourteen (14) days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within fifteen (15) days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within thirty (30) days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within thirty (30) days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within thirty (30) days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB, or TABB.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.
- B. TAB Conference: Meet with Owner, Engineer, and General Contractor/Construction Manager on approval of the TAB strategies and procedures plan to develop a mutual understanding of

the details. Require the participation of the TAB field supervisor and technicians. Provide seven (7) days' advance notice of scheduled meeting time and location.

1. Agenda Items:

- a. The Contract Documents examination report.
- b. The TAB plan.
- c. Coordination and cooperation of trades and subcontractors.
- d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

H. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

- A. Notice: Provide seven (7) days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

- A. Subject to compliance with requirements, engage one (1) of the following:

1. Advanced Testing & Balancing – Stanley Ward – (203) 931-0316
2. Air Balancing Service Co. – Michael Mauro – (203) 234-8222
3. Environmental Testing & Balancing, Inc. – (203) 234-2089
4. James E. Brennan Co, Inc – (203) 269-1454
5. Technical Associates Group, Inc – Douglas McKay – (203) 294-1820
6. Wing's Testing & Balancing – (203) 481-4988

3.2 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.
- F. Examine equipment performance data, including fan and pump curves.
 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.
- K. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.

- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 - 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning in accordance with the sequence of operation.
 - g. Shutoff and balance valves have been verified to be one hundred percent (100%) open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
 - 4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230700 "HVAC Insulation".
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

- A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
 - 1. Motors.
 - 2. Terminal units.
 - 3. Condensing units.
 - 4. Condensers.
 - 5. Air-handling units.
 - 6. Rooftop air-conditioning units.
 - 7. Computer-room air conditioners.
 - 8. Split-system air conditioners.
 - 9. Variable-refrigerant-flow systems.
 - 10. Heat pumps.
 - 11. Valance heating and cooling units.
 - 12. Coils.
 - 13. Fan coil units.
 - 14. Finned-tube radiation heaters.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' Record drawings duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.

- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

- a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, speed, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.9 PROCEDURES FOR MULTI-ZONE SYSTEMS

- A. Position the unit's automatic zone dampers for maximum flow through the cooling coil.
 - B. The procedures for multi-zone systems will utilize the zone balancing dampers to achieve the indicated airflow within the zone.
 - C. After balancing, place the unit's automatic zone dampers for maximum heating flow. Retest zone airflows and record any variances.
 - D. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
1. Measure total airflow.

- a. Set outside-air, return-air and relief-air dampers for proper position that simulates minimum outdoor air conditions.
 - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- E. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- F. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlet and outlet airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- G. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

3.10 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 - 1. Check expansion tank for proper setting.
 - 2. Check highest vent for adequate pressure.
 - 3. Check flow-control valves for proper position.
 - 4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
 - 5. Verify that motor controllers are equipped with properly sized thermal protection.
 - 6. Check that air has been purged from the system.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.
- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
 - 1. Check settings and operation of each safety valve. Record settings.

3.11 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design flow.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gauge heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
 - 3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
 - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - 1. Measure and balance coils by either coil pressure drop or temperature method.
 - 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- F. Verify final system conditions as follows:
 - 1. Re-measure and confirm that total water flow is within design.
 - 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - 3. Mark final settings.
- G. Verify that memory stops have been set.

3.12 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
- B. Adjust the variable-flow hydronic system as follows:
 - 1. Verify that the pressure-differential sensor(s) is located as indicated.
 - 2. Determine whether there is diversity in the system.
- C. For systems with no flow diversity:
 - 1. Adjust pumps to deliver total design flow.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

- b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gauge heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
 - c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
- 2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 - 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 - 4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
 - 5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 - 6. Prior to verifying final system conditions, determine the system pressure-differential set point(s).
 - 7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve one hundred percent (100%), and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 - 8. Mark final settings and verify that all memory stops have been set.
 - 9. Verify final system conditions as follows:

- a. Re-measure and confirm that total flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
 - c. Mark final settings.
- D. For systems with flow diversity:
 1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by Architect.
 3. Adjust pumps to deliver total design flow.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gauge heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
 - c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
 4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 6. For systems with pressure-independent valves at terminals:

- a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system pressure-differential set point(s).
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve one hundred percent (100%), and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
 - c. Mark final settings.

3.13 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first.
- B. Balance the secondary circuits after the primary circuits are complete.
- C. Adjust pumps to deliver total design flow.
 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gauge heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
 - D. Adjust flow-measuring devices installed in mains and branches to design water flows.
 1. Measure flow in main and branch pipes.
 2. Adjust main and branch balance valves for design flow.
 3. Re-measure each main and branch after all have been adjusted.
 - E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 1. Measure flow at terminals.
 2. Adjust each terminal to design flow.
 3. Re-measure each terminal after it is adjusted.
 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 5. Perform temperature tests after flows have been balanced.
 - F. For systems with pressure-independent valves at terminals:
 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 2. Perform temperature tests after flows have been verified.
 - G. For systems without pressure-independent valves or flow-measuring devices at terminals:
 1. Measure and balance coils by either coil pressure drop or temperature method.
 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 - H. Verify final system conditions as follows:
 1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
 3. Mark final settings.
 - I. Verify that memory stops have been set.
- 3.14 PROCEDURES FOR MOTORS
- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
 - B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.15 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

- A. Verify proper rotation of fan(s).
- B. Measure and record entering- and leaving-air temperatures.
- C. Measure and record entering and leaving refrigerant pressures.
- D. Measure and record operating data of compressor(s), fan(s), and motors.

3.16 PROCEDURES FOR AIR-COOLED CONDENSERS

- A. Verify proper rotation of fan(s).
- B. Measure and record entering- and leaving-air temperatures.
- C. Measure and record entering and leaving refrigerant pressures.
- D. Measure and record operating data of fan(s) and motor(s).

3.17 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each hydronic coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Air pressure drop.
 - 5. Voltage and amperage input of each phase at full load.
 - 6. Calculated kilowatt at full load.
 - 7. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Entering and leaving refrigerant pressure and temperatures.

3.18 SOUND TESTS

- A. After systems are balanced and Substantial Completion, measure and record sound levels at ten (10) locations as designated by the Architect.

B. Instrumentation:

1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (L_{eq}).
3. The sound-testing meter must be capable of using one-third octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus 1 decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight (8) unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight (8) unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.
 - d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on Noise Criteria (NC) worksheet with equipment on and off.

3.19 VIBRATION TESTS

- A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding non-magnetic, pointed transducer tip on end of shaft.
3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.
5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from AABC's "National Standards for Total System Balance." Acceptable levels of vibration are normally "smooth" to "good."
4. Include in General Machinery Vibration Severity Chart, with conditions plotted.

3.20 DUCT LEAKAGE TESTS

- A. Witness the duct leakage testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.21 PIPE LEAKAGE TESTS

- A. Witness the pipe pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.22 UFAD PLENUM LEAKAGE TESTS

- A. Witness the UFAD plenum pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.23 HVAC CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 1. Verify HVAC control system is operating within the design limitations.
 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 3. Verify that controllers are calibrated and function as intended.

4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: Open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.24 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a pre-construction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
4. Check the refrigerant charge.
5. Check the condition of filters.
6. Check the condition of coils.
7. Check the operation of the drain pan and condensate-drain trap.
8. Check bearings and other lubricated parts for proper lubrication.
9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the pre-construction report are corrected.

- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than five percent (5%), make equipment adjustments to achieve the calculated rates. If increase or decrease is five percent (5%) or less, equipment adjustments are not required.
4. Balance each air outlet.

3.25 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus ten percent (+/-10%). If design value is less than 100 cfm, within 10 cfm.
 - 2. Air Outlets and Inlets: Plus or minus ten percent (+/-10%). If design value is less than 100 cfm, within 10 cfm.
 - 3. Heating-Water Flow Rate: Plus or minus five percent (+-5%). If design value is less than 10 gpm, within 10 cfm.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.26 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.27 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.

7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans performance forms, including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Heating coil, dry-bulb conditions.
 - e. Face and bypass damper settings at coils.
 - f. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - g. Variable-frequency controller settings for variable-air-volume systems.
 - h. Settings for pressure controller(s).
 - i. Other system operating conditions that affect performance.
 16. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.

- h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and speed.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan speed.
 - d. Inlet and discharge static pressure in inches wg.
 - e. For each filter bank, filter static-pressure differential in inches wg.
 - f. Pre-heat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
 - j. Outdoor airflow in cfm.
 - k. Return airflow in cfm.
 - l. Outdoor-air damper position.
 - m. Return-air damper position.
- F. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.

- h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and speed.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.
- H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.

- f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft.
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and speed.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan speed.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System fan and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.

- d. Duct static pressure in inches wg.
- e. Duct size in inches.
- f. Duct area in sq. ft.
- g. Indicated airflow rate in cfm.
- h. Indicated velocity in fpm.
- i. Actual airflow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Apparatus used for test.
- d. Area served.
- e. Make.
- f. Number from system diagram.
- g. Type and model number.
- h. Size.
- i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Air velocity in fpm.
- c. Preliminary airflow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final airflow rate in cfm.
- f. Final velocity in fpm.
- g. Space temperature in deg F.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

- a. System and air-handling-unit identification.
- b. Location and zone.
- c. Room or riser served.
- d. Coil make and size.
- e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Entering-water temperature in deg F.
- c. Leaving-water temperature in deg F.
- d. Water pressure drop in feet of head or psig.
- e. Entering-air temperature in deg F.
- f. Leaving-air temperature in deg F.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump speed.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.28 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of General Contractor/Construction Manager.
- B. Architect and Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either ten percent (10%) of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

- D. If the number of "FAILED" measurements is greater than ten percent (10%) of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
- E. If recheck measurements find the number of failed measurements non-compliant with requirements indicated, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
 - 2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.
- F. Prepare test and inspection reports.

3.29 ADDITIONAL TESTS

- A. Within ninety (90) days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Insulation Materials:
 - a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
 - d. Mineral fiber.
- 2. Fire-rated insulation systems.
- 3. Insulating cements.
- 4. Adhesives.
- 5. Mastics.
- 6. Lagging adhesives.
- 7. Sealants.
- 8. Factory-applied jackets.
- 9. Field-applied fabric-reinforcing mesh.
- 10. Field-applied cloths.
- 11. Field-applied jackets.
- 12. Tapes.
- 13. Securements.
- 14. Corner angles.

- B. Related Sections:

- 1. Section 233113 "Metal Ducts" for duct liners.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Qualification Data: For qualified Installer.
- C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless-steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Industrial Insulation Group (The); **Thermo-12 Gold**
 - 2. Pre-formed Pipe Sections: Flat-, curved-, and grooved-block sections of non-combustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 3. Flat-, curved-, and grooved-block sections of non-combustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 4. Pre-fabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in pre-forming insulation to cover valves, elbows, tees, and flanges.
- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cell-U-Foam Corporation; **Ultra-CUF**
 - b. Pittsburgh Corning Corporation; **Foamglas Super K**
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Pre-formed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Pre-formed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Aeroflex USA Inc.; **Aerocel**
 - b. Armacell LLC; **AP Armaflex**
 - c. RBX Corporation; **Insul-Sheet 1800** and **Insul-Tube 180**
- I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. CertainTeed Corp.; **Duct Wrap**
 - b. Johns Manville; **Microlite**
 - c. Knauf Insulation; **Duct Wrap**
 - d. Manson Insulation Inc.; **Alley Wrap**
 - e. Owens Corning; **All-Service Duct Wrap**

- J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Johns Manville; **HTB 23 Spin-Glas**
 - b. Owens Corning; **High Temperature Flexible Batt Insulations**

- K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. CertainTeed Corp.; **Commercial Board**
 - b. Johns Manville; **800 Series Spin-Glas**
 - c. Knauf Insulation; **Insulation Board**
 - d. Owens Corning; **Fiberglas 700 Series**

- L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Johns Manville; **1000 Series Spin-Glas**
 - b. Owens Corning; **High Temperature Industrial Board Insulations**
 - c. Roxul Inc.; **Roxul RW**
 - d. Thermafiber; **Thermafiber Industrial Felt**

- M. Mineral-Fiber, Pre-formed Pipe Insulation:
 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Johns Manville; **Micro-Lok**
 - b. Knauf Insulation; **1000 Pipe Insulation**
 - c. Manson Insulation Inc.; **Alley-K**
 - d. Owens Corning; **Fiberglas Pipe Insulation**

 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- N. Mineral-Fiber, Pipe Insulation Wicking System: Pre-formed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of pre-formed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

- a. Knauf Insulation; **Permawick Pipe Insulation**
- b. Owens Corning; **VaporWick Pipe Insulation**

- O. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb./cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

- a. CertainTeed Corp.; **CrimpWrap**
- b. Johns Manville; **MicroFlex**
- c. Knauf Insulation; **Pipe and Tank Insulation**
- d. Manson Insulation Inc.; **AK Flex**
- e. Owens Corning; **Fiberglas Pipe and Tank Insulation**

2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 1 or 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, provide the following available product that may be incorporated into the Work include, but is not limited to, the following:

- a. Johns Manville; **Super Firetemp M**

- B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 1 or 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

- a. CertainTeed Corp.; **FlameChek**
- b. Johns Manville; **Firetemp Wrap**
- c. 3M; **Fire Barrier Wrap Products**

2.3 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

- a. Insulco, Division of MFS, Inc.; **Triple I**
 - b. P. K. Insulation Mfg. Co., Inc.; **Super-Stik**
 - B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. P. K. Insulation Mfg. Co., Inc.; **Thermal-V-Kote**
 - C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Insulco, Division of MFS, Inc.; **SmoothKote**
 - b. P. K. Insulation Mfg. Co., Inc.; **PK No. 127** and **Quik-Cote**
 - c. Rock Wool Manufacturing Company; **Delta One Shot**
- 2.4 ADHESIVES
- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
 - B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-97**
 - b. Foster Products Corporation, H. B. Fuller Company; **81-27/81-93**
 - c. Marathon Industries, Inc.; **290**
 - d. Mon-Eco Industries, Inc.; **22-30**
 - e. Vimasco Corporation; **760**
 - C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-96**
 - b. Foster Products Corporation, H. B. Fuller Company; **81-33**
 - D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Aeroflex USA Inc.; **Aeroseal**
 - b. Armacell LCC; **520 Adhesive**
 - c. Foster Products Corporation, H. B. Fuller Company; **85-75**
 - E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-82**
 - b. Foster Products Corporation, H. B. Fuller Company; **85-20**

- c. Marathon Industries, Inc.; **225**
 - F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-82**
 - b. Foster Products Corporation, H. B. Fuller Company; **85-20**
 - c. Marathon Industries, Inc.; **225**
 - G. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Dow Chemical Company (The); **739, Dow Silicone**
 - b. Johns-Manville; **Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive**
 - c. Red Devil, Inc.; **Celulon Ultra Clear**
- 2.5 MASTICS
- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 - B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-35**
 - b. Foster Products Corporation, H. B. Fuller Company; **30-90**
 - c. Marathon Industries, Inc.; **590**
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, fifty-nine percent (59%) by volume and seventy-one percent (71%) by weight.
 - 5. Color: White.
 - C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-30**
 - b. Foster Products Corporation, H. B. Fuller Company; **30-35**
 - c. Marathon Industries, Inc.; **501**
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F.
 - 4. Solids Content: ASTM D 1644, forty-four percent (44%) by volume and sixty-two percent (62%) by weight.
 - 5. Color: White.
 - D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **Encacel**
 - b. Foster Products Corporation, H. B. Fuller Company; **60-95/60-96**
 - c. Marathon Industries, Inc.; **570**
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, thirty-three percent (33%) by volume and forty-six percent (46%) by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-10**
 - b. Foster Products Corporation, H. B. Fuller Company; **35-00**
 - c. Marathon Industries, Inc.; **550**
2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: Sixty-three percent (63%) by volume and seventy-three percent (73%) by weight.
5. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-52**
 - b. Foster Products Corporation, H. B. Fuller Company; **81-42**
 - c. Marathon Industries, Inc.; **130**
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.7 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-76**
 - b. Foster Products Corporation, H. B. Fuller Company; **30-45**
 - c. Marathon Industries, Inc.; **405**
 - d. Pittsburgh Corning Corporation; **Pittseal 444**
2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **CP-76-8**
 - b. Foster Products Corporation, H. B. Fuller Company; **95-44**
 - c. Marathon Industries, Inc.; **405**
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Products, Division of ITW; **CP-76**
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, provide one (1) of the following:
 - 1) Dow Chemical Company (The); **Saran 540 Vapor Retarder Film** and **Saran 560 Vapor Retarder Film**
6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a

flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

- a. Products: Subject to compliance with requirements, provide one (1) of the following:

- 1) Dow Chemical Company (The); **Saran 540 Vapor Retarder Film** and **Saran 560 Vapor Retarder Film**

- 7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

- a. Products: Subject to compliance with requirements, provide one (1) of the following:

- 1) Dow Chemical Company (The); **Saran 540 Vapor Retarder Film** and **Saran 560 Vapor Retarder Film**

- 8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

- 1. Products: Subject to compliance with requirements, provide the following:

- a. Vimasco Corporation; **Elastafab 894**

- B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

- 1. Products: Subject to compliance with requirements, provide the following:

- a. Childers Products, Division of ITW; **Chil-Glas No. 5**

- C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

- 1. Products: Subject to compliance with requirements, provide one (1) of the following:

- a. Foster Products Corporation, H. B. Fuller Company; **Mast-A-Fab**
 - b. Vimasco Corporation; **Elastafab 894**

2.10 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd.

- 1. Products: Subject to compliance with requirements, provide one (1) of the following:

- a. Alpha Associates, Inc.; **Alpha-Maritex 84215** and **84217/9485RW, Luben 59**

2.11 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with Kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Johns Manville; **Zeston**
 - b. P.I.C. Plastics, Inc.; **FG Series**
 - c. Proto PVC Corporation; **LoSmoke**
 - d. Speedline Corporation; **SmokeSafe**
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: White.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 - 5. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products, Division of ITW; **Metal Jacketing Systems**
 - b. PABCO Metals Corporation; **Surefit**
 - c. RPR Products, Inc.; **Insul-Mate**
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Pre-formed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.

- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Pre-formed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Pittsburgh Corning Corporation; **Pittwrap**
 - b. Polyguard; **Insulrap No Torch 125**
- F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Polyguard; **Alumaguard 60**
- G. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Dow Chemical Company (The), **Saran 540 Vapor Retarder Film**
- H. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 1. Products: Subject to compliance with requirements, provide the following:

- a. Dow Chemical Company (The), **Saran 560 Vapor Retarder Film**
- I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Dow Chemical Company (The); **Saran 540 Vapor Retarder Film** and **Saran 560 Vapor Retarder Film**

2.12 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; **Fasson 0835**
 - b. Compac Corp.; **104** and **105**
 - c. Ideal Tape Co., Inc., an American Biltrite Company; **428 AWF ASJ**
 - d. Venture Tape; **1540 CW Plus**, **1542 CW Plus**, and **1542 CW Plus/SQ**
 - 2. Width: 3 inches.
 - 3. Thickness: 11.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: Two percent (2%).
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. ASJ Tape Disks and Squares: Pre-cut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; **Fasson 0827**
 - b. Compac Corp.; **110** and **111**
 - c. Ideal Tape Co., Inc., an American Biltrite Company; **491 AWF FSK**
 - d. Venture Tape; **1525 CW**, **1528 CW**, and **1528 CW/SQ**
 - 2. Width: 3 inches.
 - 3. Thickness: 6.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: Two percent (2%).
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. FSK Tape Disks and Squares: Pre-cut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 - 1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; **Fasson 0555**
 - b. Compac Corp.; **130**
 - c. Ideal Tape Co., Inc., an American Biltrite Company; **370 White PVC tape**
 - d. Venture Tape; **1506 CW NS**

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: Five hundred percent (500%).
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; **Fasson 0800**
 - b. Compac Corp.; **120**
 - c. Ideal Tape Co., Inc., an American Biltrite Company; **488 AWF**
 - d. Venture Tape; **3520 CW**
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: Five percent (5%).
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide the following:
 - a. Dow Chemical Company (The); **Saran 540 Vapor Retarder Tape**
2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: One hundred forty-five percent (145%).
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Dow Chemical Company (The); **Saran 560 Vapor Retarder Tape**
2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: One hundred forty-five percent (145%).
6. Tensile Strength: 55 lbf/inch in width.

2.13 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one (1) of the following:
 - a. Childers Products; **Bands**
 - b. PABCO Metals Corporation; **Bands**
 - c. RPR Products, Inc.; **Bands**

2. Stainless-Steel: ASTM A 167 or ASTM A 240, Type 304 or Type 316; 0.015-inch-thick, ¾-inch-wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, ¾-inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless-steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated.
 - a. Products: Subject to compliance with requirements, provide one (1) of the following:
 - 1) AGM Industries, Inc.; **CWP-1**
 - 2) GEMCO; **CD**
 - 3) Midwest Fasteners, Inc.; **CD**
 - 4) Nelson Stud Welding; **TPA, TPC, and TPS**
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1½-inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, provide one (1) of the following:
 - 1) AGM Industries, Inc.; **CWP-1**
 - 2) GEMCO; **Cupped Head Weld Pin**
 - 3) Midwest Fasteners, Inc.; **Cupped Head**
 - 4) Nelson Stud Welding; **CHP**
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one (1) of the following:
 - 1) AGM Industries, Inc.; **Tactoo Insul-Hangers, Series T**
 - 2) GEMCO; **Perforated Base**
 - 3) Midwest Fasteners, Inc.; **Spindle**
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
 - c. Spindle: Stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Non-metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated,

securely in position indicated when self-locking washer is in place. Comply with the following requirements:

- a. Products: Subject to compliance with requirements, provide one (1) of the following:
 - 1) GEMCO; **Nylon Hangers**
 - 2) Midwest Fasteners, Inc.; **Nylon Insulation Hangers**
 - b. Baseplate: Perforated, nylon sheet, 0.030-inch-thick by 1½ inches in diameter.
 - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2½ inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Products: Subject to compliance with requirements, provide one (1) of the following:
 - 1) AGM Industries, Inc.; **Tactoo Insul-Hangers, Series TSA**
 - 2) GEMCO; **Press and Peel**
 - 3) Midwest Fasteners, Inc.; **Self Stick**
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
 - c. Spindle: Stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1½ inches in diameter.
- a. Products: Subject to compliance with requirements, provide one (1) of the following:
 - 1) AGM Industries, Inc.; **RC-150**
 - 2) GEMCO; **R-150**
 - 3) Midwest Fasteners, Inc.; **WA-150**
 - 4) Nelson Stud Welding; **Speed Clips**
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Non-metal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1½ inches in diameter.
- a. Products: Subject to compliance with requirements, provide one (1) of the following:
 - 1) GEMCO

2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless-steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless-steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

- a. C & F Wire
- b. Childers Products
- c. PABCO Metals Corporation
- d. RPR Products, Inc.

2.14 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1-by-1-inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch-thick, minimum 1-by-1-inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024-inch-thick, minimum 1-by-1-inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless-Steel: Coat 300 series stainless-steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1½ inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

- a. For below ambient services, apply vapor-barrier mastic over staples.
- 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
- 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than seventy-five percent (75%) of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.

- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Pipe: Install insulation continuously through floor penetrations.
 - 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for one hundred percent (100%) coverage of tank and vessel surfaces.
 - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - 3. Protect exposed corners with secured corner angles.
 - 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 - 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one (1) circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between

- two (2) circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply one hundred percent (100%) coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 2. Fabricate boxes from galvanized steel, at least 0.040-inch-thick.
 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using pre-formed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with pre-formed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using pre-formed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two (2) times the thickness of pipe insulation, or one (1) pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using pre-formed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe

- insulation by not less than two (2) times the thickness of pipe insulation, or one (1) pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized pre-formed pipe insulation. Overlap adjoining pipe insulation by not less than two (2) times the thickness of pipe insulation, or one (1) pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two (2) times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two (2) halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two (2) coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
- ### 3.7 CALCIUM SILICATE INSULATION INSTALLATION
- A. Insulation Installation on Boiler Breechings and Ducts:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one (1) layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one (1) layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

C. Insulation Installation on Pipe Flanges:

1. Install pre-formed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install pre-formed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-formed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install pre-formed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1-inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install pre-formed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-formed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install pre-formed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install pre-formed valve covers manufactured of same material as pipe insulation when available.

2. When pre-formed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of pre-formed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install pre-formed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1-inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install pre-formed sections of same material as straight segments of pipe insulation when available.
2. When pre-formed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install pre-formed sections of same material as straight segments of pipe insulation when available.
2. When pre-formed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for one hundred percent (100%) coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one (1) edge and one (1) end of insulation segment. Secure laps to adjacent insulation section with ½-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for one hundred percent (100%) coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one (1) edge and one (1) end of insulation segment. Secure laps to adjacent insulation section with ½-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness but not less than 3 inches.
 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.11 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two (2) 0.062-inch- thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1½-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1. Apply two (2) continuous beads of adhesive to seams and joints, one (1) bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- E. Where PVDC jackets are indicated, install as follows:
 - 1. Apply three (3) separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 - 2. Wrap factory-pre-sized jackets around individual pipe insulation sections with one (1) end overlapping the previously installed sheet. Install pre-sized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1¼ circumferences of appropriate PVDC tape around overlapped butt joint.
 - 3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 - 4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33½ inches or less. The 33½-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one (1) time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
 - 5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1¼ circumferences to avoid damage to tape edges.

3.12 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.13 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below:
 - 1. Flat Acrylic Finish: Two (2) finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two (2) coats of insulation manufacturer's recommended protective coating.

- C. Color: Final color as selected by Architect and Owner from manufacturer's entire range. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.14 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one (1) location for each duct system defined in the "Duct Insulation Schedule, General" Article.
 - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one (1) location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 - 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three (3) locations of straight pipe, three (3) locations of threaded fittings, three (3) locations of welded fittings, two (2) locations of threaded strainers, two (2) locations of welded strainers, three (3) locations of threaded valves, and three (3) locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals non-compliance with requirements.

3.15 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in non-conditioned space.
 - 4. Indoor, exposed return located in non-conditioned space.
 - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 - 7. Outdoor, concealed supply and return.
 - 8. Outdoor, exposed supply and return.
- B. Items Not Insulated:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums and casings.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Factory-insulated access panels and doors.

3.16 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Refer to Schedule on Drawings.

3.17 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Refer to Schedule on Drawings.

3.18 EQUIPMENT INSULATION SCHEDULE

- A. Refer to Schedule on Drawings.

3.19 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable pre-formed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one (1) material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.20 INDOOR PIPING INSULATION SCHEDULE

- A. Refer to Schedule on Drawings.

3.21 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refer to Schedule on Drawings.

3.22 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Refer to Schedule on Drawings.

3.23 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Refer to Schedule on Drawings.

3.24 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Refer to Schedule on Drawings.

3.25 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230700

SECTION 230800 – COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The OPR and BOD documentation are required from the EOR to be included by reference to the Cx.

1.2 SUMMARY

- A. This section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Section 230500 Through 238126.13 – HVAC
 - 2. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "General Commissioning Requirements" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "General Commissioning Requirements" for Cx's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements.
- C. In addition, provide the following:
 - 1. Certificates of readiness
 - 2. Certificates of completion of installation, prestart, and startup activities.
 - 3. O&M manuals
 - 4. Test reports
- D. Control Drawings Submittal
 - 1. The control drawings shall have a key to all abbreviations.

2. The control drawings shall contain graphic schematic depictions of the systems and each component.
3. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
4. Provide a full points list with at least the following included for each point:
 - a. Controlled system
 - b. Point abbreviation
 - c. Point description
 - d. Display unit
 - e. Control point or set point (Yes / No)
 - f. Monitoring point (Yes / No)
 - g. Intermediate point (Yes / No)
 - h. Calculated point (Yes / No)

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to Cx upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC&R system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the Cx.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the

following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

A. Red-lined Drawings:

1. The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
2. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.
4. The contracted party, as defined in the Contract Documents will create the as-built drawings.

B. Operation and Maintenance Data:

1. Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
2. The Cx will review the O&M literature once for conformance to project requirements.
3. The Cx will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.

C. Demonstration and Training:

1. Contractor will provide demonstration and training as required by the specifications.
2. A complete training plan and schedule must be submitted by the contractor to the Cx four weeks (4) prior to any training.
3. A training agenda for each training session must be submitted to the Cx two (2) weeks prior the training session.
4. The Cx shall be notified at least 72 hours in advance of scheduled tests so that testing may be observed by the Cx and Owner's representative. A copy of the test record shall be provided to the Cx, Owner, and Architect.
5. Engage a Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.
6. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment.
7. Review data in O&M Manuals.

D. Systems manual requirements:

1. The Systems Manual if required is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
2. The Contractor shall include final approved versions of the following information for the Systems Manual:

- a. As-Built System Schematics
 - b. Verified Record Drawings
 - c. Test Results (PFT's)
 - d. Periodic Maintenance Information for computer maintenance management system
 - e. Recommendations for recalibration frequency of sensors and actuators
 - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - g. Training Records, Information on training provided, attendees list, and any on-going training
- 3. This information shall be organized and arranged by building system, such as fire alarm, heat pumps, heating hot water, etc.
 - 4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Mechanical, Controls and TAB Contractors. The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of Division 23 are as follows (all references apply to commissioned equipment only):
- B. Perform commissioning tests at the direction of the Cx.
- C. Attend construction phase controls coordination meetings.
- D. Attend testing, adjusting, and balancing review and coordination meetings.
- E. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the Cx.
- F. Provide information requested by the Cx for final commissioning documentation.
- G. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- H. Prepare preliminary schedule for Mechanical system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, testing and balancing and task completion for owner. Distribute preliminary schedule to commissioning team members.
- I. Update schedule as required throughout the construction period.
- J. During the startup and initial checkout process, execute the related portions of the prefunctional checklists for all commissioned equipment.
- K. Assist the Cx in all verification and functional performance tests.
- L. Provide measuring instruments and logging devices to record test data and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- M. Gather operation and maintenance literature on all equipment and assemble in binders as required by the specifications.

- N. Coordinate with the Cx to provide (72) hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- O. Notify the Cx a minimum of (2) weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.
- P. Participate in, and schedule vendors and contractors to participate in the training sessions.
- Q. Provide written notification to the CM and Cx Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
 - 1. HVAC&R equipment including all fans, air handling units, ductwork, dampers, terminals, and all other equipment furnished under this Division.
 - 2. Fire stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
 - 3. Fire detection and smoke detection devices furnished under other divisions of the specification.
Building Automation and Control System and approved sequences of operations
- R. The equipment supplier shall document the performance of his equipment.
- S. Provide a complete set of red-lined drawings to the Cx prior to the start of Functional Performance Testing.
- T. Test, Adjust and Balance Contractor
 - 1. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
 - 2. Submit the site specific testing and balancing plan to the Cx and AE for review and acceptance.
 - 3. Attend the testing and balancing review meeting scheduled by the Cx. Be prepared to discuss the procedures that shall be followed in testing, adjusting, and balancing the HVAC&R system.
 - 4. At the completion of testing and balancing work, and the submittal of the final testing and balancing report, notify the HVAC&R Contractor and the CM.
 - 5. Participate in verification of the testing and balancing report, which will consist of repeating measurements contained in the testing and balancing reports. Assist in diagnostic purposes when directed.
- U. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
- V. Equipment Suppliers
 - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
 - 2. Assist in equipment testing per agreements with contractors.
 - 3. Provide information requested by Cx regarding equipment sequence of operation and testing procedures.
- W. Refer to Division 01 Section "General Commissioning Requirements" for additional contractor responsibilities.

3.3 OWNER'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for Owner's Responsibilities.

3.4 DESIGN PROFESSIONAL'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for Design Professional's Responsibilities.

3.5 Cx'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for Cx's Responsibilities.

3.6 TESTING PREPARATION

- A. Certify in writing to the Cx that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the Cx that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the Cx.

3.7 TESTING, ADJUSTING AND BALANCING VERIFICATION

- A. Prior to performance of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, and certificates to the Cx
- B. Notify the Cx at least ten (10) days in advance of testing and balancing Work and provide access for the Cx to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the Cx.

1. The Cx will notify testing and balancing subcontractor ten (10) days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the Cx so verification of failed portions can be performed.

3.8 GENERAL TESTING REQUIREMENTS

- A. Provide Mechanical and Controls technicians, instrumentation, and tools to perform commissioning tests at the direction of the Cx.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The Cx along with the HVAC&R Contractor, Testing and Balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the Cx and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The Cx may direct that set points be altered when simulating conditions is not practical.
- H. The Cx may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.9 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 23 sections and Division 1 General Commissioning Requirements. Provide submittals, test data, inspector record, and certifications to the Cx.

- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 230913 Sections "Instrumentation and Control for HVAC" and 230993 "Sequence of Operations for HVAC Controls assist the Cx with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment: Test requirements are specified in Division 232113 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the Cx. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The Cx shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- E. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- F. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:
 - 1. Packaged Rooftop Air Handling Units
 - 2. HW Pumps (Primary and Secondary)
 - 3. Hot Water Piping
 - 4. VAV Boxes
 - 5. Cabinet Unit Heaters, Unit Heaters, and RCP
 - 6. Low-Leak Automatic Control Dampers
 - 7. Ductwork (Observe Pressure Testing if specified)
 - 8. Exhaust Fans
 - 9. Glycol System
 - 10. Variable Frequency Drives
 - 11. Humidification & Dehumidification Systems
 - 12. Building Automation System
 - 13. TAB Services

3.10 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.11 APPROVAL

- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.

3.12 DEFERRED TESTING

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.

3.13 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section "General Commissioning Requirements" for the AE and Cx roles in the Operation and Maintenance Manual contribution, review and approval process.
- C. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.

3.14 TRAINING OF OWNER PERSONNEL

- A. Contractor shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed. Refer to Section 019113, for requirements pertaining to training.
- B. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:
 - 1. Provide the Cx with a training plan two (2) weeks before the planned training.
 - 2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, all HVAC equipment (ex. pumps, heat exchangers, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.)
 - 3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation.
 - 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 - 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
 - 6. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
 - 7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

8. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Cover common troubleshooting problems and solutions.
 - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
9. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
10. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
11. Training shall occur after functional testing is complete, unless approved otherwise by the Owner or Owners Representative.

C. Controls Contractor. The controls contractor shall have the following training responsibilities:

1. Provide Cx and AE with a training plan four (4) weeks before the planned training.
2. The controls contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner on all the capabilities of the control system.
3. Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the Cx and AE. Copies of audiovisuals shall be delivered to the Owner.
4. The trainings will be tailored to the needs and skill-level of the trainees.
5. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.
6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
7. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
8. There shall be three (3) training sessions:
 - a. Training I. Control System. The first training shall consist of 2-hours of actual training. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.

- b. Training II. Building Systems. The second session shall be held on-site for a period of 4-hours of actual hands-on training after the completion of system commissioning. The session shall include instruction on:
- 1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.
 - 2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing set points and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
 - 3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.
 - 4) Every screen shall be completely discussed, allowing time for questions.
 - 5) Use of keypad or plug-in laptop computer at the zone level.
 - 6) Use of remote access to the system via phone lines or networks.
 - 7) Setting up and changing an air terminal unit controller.
 - 8) Graphics generation
 - 9) Point database entry and modifications
 - 10) Understanding DDC field panel operating programming (when applicable)
- c. Training III. The third training will be conducted on-site six months after occupancy and consist of 4-hours of training. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

END OF SECTION 230800

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control equipment and installation for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-furnished controls.
- B. The control system shall be extension of the existing Siemens Building Automation System and all controllers and software shall match existing or be the latest version of existing.
- C. Refer to Section 230993 "Sequences of Operation" for requirements that relate to this Section.
- D. Related Sections:
 - 1. Section 230593 "Testing, Adjusting, and Balancing for HVAC".
 - 2. Section 260500 "Common Work Results for Electrical".
 - 3. Section 260519 "Low-Voltage Electrical Power Conductors and Cables".
 - 4. Section 260529 "Hangers and Supports for Electrical Systems".
 - 5. Section 260533 "Raceway and Boxes for Electrical Systems".
 - 6. Section 260553 "Identification for Electrical Systems".
 - 7. Section 262726 "Wiring Devices".

1.3 ABBREVIATIONS

- A. AAC: Advanced Application Controller
- B. AHU: Air Handling Unit
- C. ALN: Automation Level Network
- D. ASC: Application Specific Controller
- E. ASHRAE: American Society of Heating Refrigerating and Air-Conditioning Engineers
- F. BACnet SC: Building Automation Control Network Secure Connect
- G. BAS: Building Automation System
- H. BC: Building Controller
- I. BIBB: BACnet Interoperability Building Blocks
- J. BIM: Building Information Modeling
- K. BMS: Building Management System

- L. CFM: Cubic Feet per Minute
- M. DCIM: Data Center Infrastructure Management
- N. DCV: Demand Controlled Ventilation
- O. DDC: Direct Digital Controls
- P. EIA: Electronics Industries Alliance
- Q. EMI: Electro-Magnetic Interference
- R. EP: Electric-to-Pneumatic
- S. EPMS: Electrical Power Monitoring System
- T. FAS: Fire Alarm System.
- U. FLN: Floor Level Network
- V. FCU: Fan Coil Unit
- W. HMI: Human Machine Interface
- X. HVAC: Heating, Ventilating, and Air Conditioning
- Y. IEEE: Institute of Electrical and Electronic Engineers
- Z. I/O: Input/Output
- AA. IP: Internet Protocol
- BB. IT: Information Technology
- CC. LAN: Local Area Network
- DD. LCD: Liquid Crystal Display
- EE. LED: Light Emitting Diode
- FF. MER: Mechanical Equipment Room
- GG. MLN: Management Level Network
- HH. MS/TP: Master-slave/token-passing
- II. NEMA: National Electric Manufacturers' Association
- JJ. NFPA: National Fire Protection Association
- KK. OEM: Operator Equipment Manufacturer
- LL. PC: Personal Computer
- MM. PICS: Protocol Implementation Conformance Statement

- NN. PID: Proportional Integral Derivative
- OO. POT: Portable Operators Terminal
- PP. RAM: Random Access Memory
- QQ. RFI: Radio Frequency Interference
- RR. RTD: Resistance Temperature Device
- SS. SNMP: Simple Network Management Protocol
- TT. TAB: Testing and Balancing
- UU. TCP: Transfer Control Protocol
- VV. UDP: User Datagram Protocol
- WW. UL: Underwriters Laboratories
- XX. UPS: Uninterruptable Power Supply
- YY. VAV: Variable Air Volume
- ZZ. VFD: Variable Frequency Drive
- AAA. WAN: Wide Area Network

1.4 DEFINITIONS

- A. BACnet: An industry standard data communication protocol for Building Automation and Control Networks. Refer to the latest version of AHSRAE standard 135.
- B. BACnet Secure Connect: As an addendum to the BACnet protocol, it is a secure, encrypted datalink layer that is specifically designed to meet the requirements of managed IP infrastructures.
- C. Scope Terminology:
 - 1. Provide = Furnish equipment, engineer, program, and install.
 - 2. Furnish = Furnish equipment, engineer, and program.
 - 3. Mount = Securely fasten or pipe.
 - 4. Install = Mount and wire.
 - 5. Wire = Wire only.

1.5 WORK INCLUDED

- A. The BAS Contractor shall provide a complete and operational system that will perform the sequences of operation as described herein.
- B. Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all system controllers, logic controllers, and all input/output devices. Items of work included are as follows:
 - 1. Provide a submittal that meets the requirements below for approval.

2. Coordinate installation schedule with the mechanical contractor and General Contractor.
 3. Provide installation of all panels and devices unless otherwise stated.
 4. Provide power for panels and control devices unless otherwise stated.
 5. Provide all low voltage control wiring for the DDC system.
 6. Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.
 7. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
 8. Provide testing, demonstration and training as specified below.
- C. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the Shop Drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer.

1.6 SUBMITTALS

- A. Provide submittals for fast-track items that need to be approved and released to meet the schedule of the project. Provide submittals for the following items separately upon request:
1. Valve schedule and product data.
 2. Damper schedule and product data.
 3. Mounting and wiring diagrams for factory-installed control components.
 4. Thermostat locations.
- B. Provide a complete submittal with all controls system information for approval before construction starts. Include the following:
1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 2. Wiring Diagrams: Power, signal, and control wiring. Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.
 3. Details of control panel faces, including sizes, controls, instruments, and labeling.
 4. Schedule of dampers and actuators including size, leakage, and flow characteristics. If dampers are furnished by other, submit a damper actuator schedule coordinating actuator sizes with the damper schedule.
 5. Schedule of valves including leakage and flow characteristics.
 6. Written description of the Sequence of Operations.
 7. Network riser diagram showing wiring types, network protocols, locations of floor penetrations, and number of control panels. Label control panels with network addresses and BACnet device instance numbers. Show all routers, switches, hubs, and repeaters.
 8. Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device.
 9. Starter and variable frequency drive wiring details of all automatically controlled motors.
 10. Reduced size floor plan drawings showing locations of control panels, thermostats and any devices mounted in occupied space.
 11. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated. Submit a write-up of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.

12. Submit BACnet Protocol Implementation Conformance Statements (PICS) for all direct digital controllers, software and other system components that will communicate on the BAS utilizing BACnet.
- C. Submit a description of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.
- D. Submit blank field check-out and commissioning test reports, customized for each panel or system, which will be filled out by the technician during start-up.
- E. Variance Letter: Submit a letter detailing each item in the submission that varies from the contract specification or sequence of operation in any way.
- F. After the BAS system is approved for construction, submit sample operator workstation graphics for typical systems for approval. Print and submit the graphics that the operator will use to view the systems, change setpoints, modify parameters, and issue manual commands. Programming shall not commence until typical graphics are approved.
- G. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
 2. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 4. Calibration records and list of set points.

1.7 PROJECT RECORD DOCUMENTS

- A. Project Record Documents: Comply with requirements in Section 017839 "Project Record Documents". As a minimum, submittal shall consist of:
 1. Project Record Drawings: As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11-x-17-inch prints.
 2. Testing and Commissioning Reports and Checklists: Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.
 3. Operation and Maintenance (O & M) Manual:
 - a. As-built versions of the submittal product data.
 - b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
 - c. Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - d. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.

- f. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
 - g. Graphic files, programs, and database on electronic media.
 - h. List of recommended spare parts with part numbers and suppliers.
 - i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
 - j. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 - k. Licenses, guarantees, and warranty documents for equipment and systems.
- B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
 - 1. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.
 - 2. Description of manual override operation of all control points in system.
 - 3. BMS system manufacturers complete operating manuals.
- C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:
 - 1. Complete as-built installation drawings for each building system.
 - 2. Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.
 - 3. Photographs and/or drawings showing installation details and locations of equipment.
 - 4. Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.
 - 5. Parts list with manufacturer's catalog numbers and ordering information.
 - 6. Lists of ordinary and special tools, operating materials supplies, and test equipment recommended for operation and servicing.
 - 7. Manufacturer's operation, set-up, maintenance and catalog literature for each piece of equipment.
 - 8. Maintenance and repair instructions.
 - 9. Recommended spare parts.
- D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:
 - 1. Complete programming manuals and reference guides.
 - 2. Details of any custom software packages and compilers supplied with system.
 - 3. Information and access required for independent programming of system.

1.8 QUALITY ASSURANCE

- A. Codes:
 - 1. Perform all wiring in accordance with Division 26, NEC, local codes, and Owner's requirements.
 - 2. 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.
 - 3. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
 - 4. Comply with ASHRAE 135-2010 BACnet: A Data Communication Protocol for Building Automation and Control Networks.

5. Comply with BACnet Secure Connect Communication: A secure, encrypted datalink layer that is specifically designed to meet the requirements of managed IP infrastructures.
 6. Comply with ASHRAE 90.1- Energy Standard for Buildings Except Low-Rise Residential Buildings.
 7. All equipment shall be UL listed and approved and shall meet all applicable NFPA standards, including UL 916 - PAZX Energy Management Systems.
 - a. Provide written approvals and certifications after installation has been completed.
 8. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
 9. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will ensure consistency in the products delivered for this project.
- B. Qualifications:
1. Installing contractor shall be in the business of installing and servicing DDC controls for mechanical systems, temperature and ventilation control, environmental control, lighting control, access and security, life safety, and energy management as their primary business.
 2. Installer Qualifications: An experienced installer who is the authorized representative of the automatic control system manufacturer for both installation and maintenance of controls required for this Project.
 3. Engineering, drafting, programming, and graphics generation shall be performed by Siemens qualified engineers and technicians directly employed by the Building Automation System Contractor.
 4. Supervision, checkout and commissioning of the system shall be by the local branch engineers and technicians directly employed by the Building Automation System Contractor. They shall perform commissioning and complete testing of the BAS system.
- C. The BAS contractor shall maintain a service organization consisting of factory-trained service personnel and provide a list of ten (10) projects, similar in size and scope to this project, completed within the last five (5) years.
- D. Final determination of compliance with these specifications shall rest solely with the Engineers and Owner who will require proof of prior satisfactory performance.
- E. For any BAS system and equipment submitted for approval, the BAS contractor shall state what, if any, specific points of system operation differ from these specifications.
- F. All portions of the system must be designed, furnished, installed, commissioned, and serviced by manufacturer approved, factory trained employees.
- G. The system shall have a documented history of compatibility by design for a minimum of minimum (15) years. Future compatibility shall be supported for no less than ten (10) years. Compatibility shall be defined as the ability for any existing control system component including but not limited to building controllers, advanced application controllers, application specific, personal operator workstations and portable operator's terminals, to be connected and directly communicate with any new BAS system equipment without bridges, routers or protocol converters.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.
- B. Deliver, store, protect, and handle products to site under provisions of the contract Documents. Coordinate all site deliveries with General Contractor/Construction Manager.
- C. Protect products from construction operations, dust, and debris, by storing materials inside, protected from weather in a conditioned space.

1.10 COORDINATION

- A. Coordinate IP drops, network connections, user interfaces, firewall, etc with Owner's IT representative.
- B. Coordinate location of thermostats, humidistats, panels, and other exposed control components with plans and room details before installation.
- C. Coordinate equipment with Division 28 "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate power for control units and operator workstation with electrical contractor.
- E. Coordinate equipment with provider of starters and drives to achieve compatibility with motor starter control coils and VFD control wiring.
- F. Coordinate scheduling with the mechanical contractor and General Contractor. Submit a schedule for approval based upon the installation schedule of the mechanical equipment.
- G. Coordinate installation of taps, valves, airflow stations, etc. with the mechanical contractor.
- H. Products Furnished but Not Installed Under This Section:
 - 1. Hydronic and Refrigerant Piping Accessories:
 - a. Control valves.
 - b. Temperature sensor wells and sockets.
 - c. Pressure sensor wells and sockets.
 - d. Flow switches.
 - e. Flow meters.
 - f. Differential pressure transmitters.
 - 2. Sheet Metal Accessories:
 - a. Dampers.
 - b. Airflow stations.
 - c. Terminal unit controls.
- I. Products Installed but Not Furnished Under This Section:
 - 1. Refrigeration Equipment:
 - a. Refrigerant leak detection system.
 - b. Proof of flow pressure switches.

2. Rooftop Air Handling Equipment:

- a. Thermostats.
- b. Duct static pressure sensors.

1.11 WARRANTY

- A. Provide warranty per Section 230000 "Basic Mechanical Requirements" and as supplemented in this Section.
- B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of twelve (12) months from completion of system demonstration.
- C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.
- D. During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner's Representative.
- E. This warranty shall apply equally to both hardware and software.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. The Building Automation System (BAS) contractor shall furnish and install a networked system of HVAC controls. The contractor shall incorporate direct digital control (DDC) for central plant equipment, building ventilation equipment, supplemental heating and cooling equipment, and terminal units.
- B. The control system for this project shall be an extension of the Owner's existing Siemens Building Automation System and all controllers and software shall match existing or be latest version of existing.
 - 1. The BAS shall be the Siemens **APOGEE System** as manufactured by Siemens Industry, Inc.
- C. Provide networking to new DDC equipment using industry accepted communication standards. System shall utilize BACnet communication according to ANSI/ASHRAE Standard 135 for interoperability with smart equipment, for the main IP communication trunk to the BAS Server and for peer-to-peer communication between DDC panels and devices. The system shall not be limited to only standard protocols, but shall also be able to integrate to a wide variety of third-party devices and applications via drivers and gateways.
- D. Provide standalone controls where called for on the Drawings or sequences.

2.2 BUILDING AUTOMATION SYSTEM NETWORK

- A. All networked control products provided for this project shall be comprised of an industry standard open protocol internetwork. Communication involving control components (i.e. all types of controllers and operator interfaces) shall conform to ASHRAE 135 BACnet standard. Networks and protocols proprietary to one (1) company or distributed by one (1) company are prohibited.

- B. Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.
 - 1. Software applications, features, and functionality, including administrative configurations, shall not be separated into several network control engines working together.
- C. BAS Server shall be capable of simultaneous direct connection and communication with BACnet/SC, BACnet/IP, OPC, and TCP/IP corporate level networks without the use of interposing devices.
- D. Any break in Ethernet communication from the server to the controllers on the Primary Network shall result in a notification at the server.
- E. Any break in Ethernet communication between the server and standard client workstations on the Primary Network shall result in a notification at each workstation.
- F. The network architecture shall consist of three (3) levels of networks:
 - 1. The Management Level Network (MLN) shall utilize BACnet/IP over Ethernet along with other standardized protocol, such as web services, html, JAVA, SOAP, XML, etc., to transmit data to non-BAS software applications and databases. The BAS Server and Operator Workstations shall reside on this level of the network architecture.
 - 2. The Automation Level Network (ALN) shall utilize BACnet/IP over Ethernet. It shall connect BACnet Building Controllers to the BAS Server and Operator Workstations. Controllers for central plant equipment and large infrastructure air handlers shall reside on the ALN backbone BACnet/IP network. The building's Ethernet LAN shall be utilized for the ALN backbone and all ALN devices shall be connected to the building's LAN. Coordinate IP drops with Owner. All ALN devices shall support BACnet/SC or be BACnet/SC-ready at minimum.
 - 3. The Floor Level Network shall utilize BACnet/IP over Ethernet or BACnet MS/TP over RS-485 to connect all the DDC-controlled terminal heating and cooling equipment on a floor or in a system that are controlled with BACnet Advanced Application Controllers or BACnet Application Specific Controllers. FLN devices are networked to a router that connects to the Automaton Level Network backbone.
- G. BAS controllers utilizing BACnet/SC and that reside on a BACnet/SC network shall support the following:
 - 1. System controllers shall be native-BACnet/SC or shall be BACnet/SC-ready by future firmware upgrade to provide data encryption utilizing secure Websocket protocol with TLS V1.3 (WSS) functioning on TCP/IP.
 - 2. System controllers shall be native-BACnet/SC or shall be BACnet/SC-ready by future firmware upgrade to provide device authentication of those BACnet/SC devices by utilizing the X.509 International Telecommunication Union standard defining the format of PKI certificates.
 - 3. System controllers shall utilize two (2) BACnet/SC hubs per BACnet network for logical function. A primary hub is required for communication to occur on the BACnet/SC network. A secondary failover hub shall be required to ensure communication can resume in the case of primary hub failure.
 - a. BACnet/SC hubs shall be embedded devices on the BACnet/SC network.
 - b. BACnet/SC hub-capable controllers shall support routing between different BACnet data link types such as BACnet/SC-to-BACnet/IP routing.

- c. BACnet/SC controllers with BACnet/SC hub functionality must support a minimum of one hundred (100) node connections per hub.
- 4. System controllers shall support BACnet/SC node, or BACnet/SC hub+node functionality (natively or with future firmware upgrade) for the system to function.
- 5. BACnet/SC must support Certificate Authority (CA) and Certificate Management:
 - a. BAS provider must provide software tools for Certificate Authority and Certificate Management.
 - b. The software tool must be made available to interact with the customer's IT department infrastructure by exchanging certificates and CSR (Certificate Signing Request) for certificate management of the BACnet/SC system for the life of the building automation system.
 - c. The BACnet/SC solution must allow for an internal-to-the-organization Certificate Authority (self-signed certificates) utilizing a software tool method capable of generating, signing, and provisioning certificates to the BAS vendor's devices, and revoking certificates completely on its own.
 - d. The BACnet/SC Certificate Management must allow for interaction with a trusted 3rd party CA for customers. The BAS vendor provided software tool for generating certificates and provisioning them to the vendor's devices must be able to generate a CSR and be able to export the required common Root Certificate (aka Issuer Certificate) on a file level to be signed by a trusted 3rd party certificate authority of the customer's preference as well as be able to import the signed certificate and provision it to the vendor's devices along with the required unique Operational Certificates (aka Client Certificates).
 - e. Certificate Management must allow for interoperability with 3rd party vendor BACnet/SC certificate management methods and allow for CA migration (CA1 -> CA2).
 - f. The certificates validity period shall be configurable in the vendor's certificate management tool to comply with customer security requirements. This shall be configurable for a minimum of one (1) week or years to a maximum of twenty-five (25) years.
 - g. The vendor specific BACnet/SC configuration and management tool from each and every BACnet/SC vendor on the project as well as the corresponding project database containing the Root Certificate must be provided to the customer for ongoing certificate management as well as vendor coordination on the project.
- H. Provide a router for each RS-485 subnetwork to connect them to the base building backbone level network. The router shall connect BACnet MS/TP subnetworks to BACnet over Ethernet. Routers shall be capable of handling all the BACnet BIBBs that are listed for the controller that reside on the subnetwork.
- I. The Building Level Controllers shall be able to support subnetwork protocols that may be needed depending on the type of equipment or application. Subnetworks shall be limited to:
 - 1. BACnet MS/TP
 - 2. Apogee FLN
 - 3. Modbus
- J. BACnet MSTP Setup Rules:
 - 1. Addressing for the MSTP devices shall start at 00 and continue sequentially for the number of devices on the subnetwork.
 - 2. No gaps shall be allowed in the addresses.
 - 3. Set the MaxMaster property to the highest address of the connected device.
 - 4. MaxMaster property shall be adjusted when devices are added to the subnetwork.

- K. Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for the internetwork.
- L. Controllers and software shall be BTL listed at the time of installation.
- M. The system shall meet peer-to-peer communication services such that the values in any one (1) BACnet Building Controller or BACnet Advanced Application Controller can be read or changed from all other controllers without the need for intermediary devices. The software shall provide transparent transfer of all data, control programs, schedules, trends, and alarms from any one (1) controller through the internetwork to any other controller, regardless of subnetwork routers.
- N. Systems that use variations of BACnet using Point-to-Point (PTP) between controllers, gateways, bridges, or networks that are not peer-to-peer are not allowed.
- O. Remote Communications: Provide a TCP/IP compatible communication port for connection to the Owner's network for remote communications. Provide coordination with the Owner for addressing and router configuration on both ends of the remote network.
- P. The system shall be installed with a ten percent (10%) spare capacity on each subnetwork for the addition of future controllers.
- Q. On each floor, wing, or major mechanical room provide an Ethernet RJ45 connection that allows connection to the BACnet network. An open port shall always be available and shall not require any part of the network to be disconnected. The location shall be accessible to the base building personnel and not in a location where the tenant can restrict the access.
- R. Distributed Control Requirements:
 - 1. The loss of any one (1) DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.
 - 2. The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.
 - 3. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.
 - 4. DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller on the network without dependence upon a central processing device. DDC Controllers shall also be able to send alarms to multiple operator workstations without dependence upon a central or intermediate processing device.
 - 5. Operators shall have the ability to make database changes at the central system server while operator workstations are on-line without disrupting other system operations.
 - 6. The DDC control panel shall be mounted in the same mechanical room as the equipment being controlled, or an adjacent utility room.
 - 7. Multiple systems can be programmed on the same controller as long as they are in the same room. Systems on separate floors shall have separate controllers. VAV boxes subnetworks shall be connected to the AHU controller that feeds those boxes.
 - 8. If multiple subnetworks are needed, then the VAV shall be grouped into subnetworks in an orderly method, such as per floor, per wing, etc.
 - 9. Remote sensors shall be wired to the control panel of the equipment it is controlling, not across the network.

10. Signals to remote motor control centers shall be hard wired to the control panel, not across the network.
11. Terminal units shall each have their own controller. Only exceptions are:
 - a. Groups of reheat coils.
 - b. Groups of exhaust fans.
 - c. Groups of chilled beams serving same zone or several adjacent zones.

2.3 BUILDING AUTOMATION SYSTEM SERVER HARDWARE

- A. Integrate the new work to the existing facility BAS server hardware.
- B. Expand the existing software license capacity to accommodate new control points and integrations.

2.4 BACNET ADVANCED WORKSTATION SOFTWARE

A. Interface Description:

1. The software shall provide, as a minimum, the following functionality:
 - a. Real-time graphical viewing and control of the BMS environment.
 - b. Reporting of both real-time and historical information.
 - c. Scheduling and override of building operations.
 - d. Collection and analysis of historical data.
 - e. Point database editing, storage and downloading of controller databases.
 - f. Configuration of and navigation through default and personalized hierarchical "tree" views that include workstation and control system objects.
 - g. Event reporting, routing, messaging, and acknowledgment.
 - h. Definition and construction of dynamic color graphic displays.
 - i. Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
 - j. On-screen access to User Documentation, via online help or PDF-format electronic file.
 - k. Automatic database backup at the operator interface for database changes initiated at Building Controllers.
 - l. Display dynamic trend data graphical plot:
 - 1) Must be able to run multiple plots simultaneously.
 - 2) Each plot must be capable of supporting ten (10) pts/plot minimum.
 - 3) Must be able to command points from selection on dynamic trend plots.
 - 4) Must be able to plot real-time data without prior configuration.
 - 5) Must be able to plot both real-time and historical trend data simultaneously.
 - m. Program editing.
 - n. Transfer trend data to third-party spreadsheet software.
 - o. Scheduling reports.
 - p. Operator Activity Log.
2. Operator interface software shall minimize operator training through the use of user-friendly and interactive graphical applications.
3. Users must be able to build multiple, separate, personalized hierarchical "tree" views that represent the workstation, control systems, geographical facility layouts, and mechanical equipment relationships.

4. 256-character point identification (names) must be supported to provide clearly descriptive identification.
5. On-line help must be available.
6. The user interface shall display relevant information for a selection in multiple panes of a single window without the need for opening multiple overlapping windows on the desktop.
7. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation.
8. Software navigation shall be user friendly by utilizing "forward & back" capability between screens and embedded links to graphics, documents, drawings, trends, schedules, as well as external documents (.doc, .pdf, .xls, etc.) or web addresses that are related to any selected object.
9. Primary selection of objects in the operator interface software shall be available from user defined hierarchical Views, from graphics, or from events in an Event List.
10. Secondary selection of objects in the operator interface software shall be available from links to any objects or external documents related to the primary selection.
11. Links to information related to any selected objects shall be displayed in a consistent manner and automatically defined based on where an object is used in the system.
12. The operator workstation shall be capable of displaying web pages and common document formats (.doc, .xls, .pdf) within the operator workstation application.
13. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously.
14. System database parameters shall be stored within an object-oriented database.
15. Standard Windows applications shall run simultaneously with the BMS software.
16. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BMS alarms and monitoring information.
17. Provide automatic backup and restore of all Building Controller databases on the workstation hard disk.
18. System configuration, programming, editing, and graphics generation shall be performed on-line from the operator workstation software.
19. User shall be able to edit point configuration of any configurable BACnet point that resides in devices that support external editing.
20. The software shall also allow the user to configure the alarm management strategy for each point.
21. Users shall have the ability to view the program(s) that is/are currently running in a Building Controller. The display shall mark the program lines with the following: disabled, comment, unresolved, and trace bits.

B. Certifications and Approvals:

1. BAS software shall have been tested against the following norms and standards:
 - a. BACnet Revision 1.13, certified by BACnet Testing Laboratory as BACnet Advanced Workstation Software (BTL B-AWS).
 - b. IT security compliant with the ISA-99/IEC 62443 Security Level: SL1.
 - c. OPC DA V2.05a and V3.0 Server, certified by the OPC Foundation certification program.
 - d. UL-listed to UL864 9th edition Standard for Control Units and Accessories (when installed on a UL-approved computer).

C. Client-Server Connectivity:

1. Client sessions must be allowed to run on the server and on other devices connected to the server via Intranet, Extranet, or Internet connections.

2. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support remote access features.
3. The following client options must be supported:
 - a. Installed Client:
 - 1) Software application installed from installation media on to the client machine.
 - 2) Installed client software must be configurable to allow it to run in a Closed Mode such that the BAS software can lock down the client machine and prevent users without permission from minimizing the application or running other Windows applications that might cover the BAS software interface.
 - 3) Communication between the server and Installed Clients must be monitored so that any break in communication between the server and an installed client results in notification at the Server and Installed Client machine.
 - 4) Installed client machines communicate directly with the BAS server.
 - b. Web Client:
 - 1) Software that runs in a browser on the client machine as a Full Trust client application.
 - 2) Connected to the BAS software server via Microsoft IIS Server.
 - c. Windows App:
 - 1) Software application downloaded from the BAS server to run on the client machine like an installed application.
 - 2) Application must be automatically updated whenever new apps are available at the server.
 - 3) Connected to the BAS software server via Microsoft IIS Server.
4. Each of the client options shall provide the same functionalities including operation and configuration capabilities.

D. Access Rights and User Privileges:

1. Access to any client user session must be password protected.
2. Users shall be able to create local user accounts specific to the application software.
3. Users shall be able to link application user accounts to Active Directory user accounts for consistent management with domain user accounts.
4. Operator-specific password access protection shall be provided to allow the administrator/manager to limit users' workstation control, display, and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned username and password.
5. Operator privileges shall follow the operator to any workstation logged onto.
6. The administrator/manager shall be able to further limit operator privileges based on which console an operator is logged on to.
7. The administrator/manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BMS workstation application.

E. Activity Logging:

1. The operator interface software shall maintain a log of the actions of each individual operator.

2. The software shall provide an application that allows querying based on object name, operator, action, or time range.
3. The software shall provide the ability to generate reports showing operator activity based on object name, operator, action, or time range.

F. Graphics Application:

1. All graphics shall be available with the same look and functionality whether they are displayed at an installed client console or in a browser.
2. User shall be able to add/delete/modify system graphics for floor plan displays and system schematics for each piece of mechanical equipment (including, air handling units, chilled water systems, hot water boiler systems, and room level terminal units) from standard user interface without the need of any external or specialized tools.
3. The software shall include all necessary tools and procedures for the user to create their own graphics.
4. The software shall provide the user the ability to display real-time point values by animated motion or custom picture control visual representation.
5. The software shall provide animation that depicts movement of mechanical equipment, or air or fluid flow.
6. The software shall provide users the ability to depict various positions in relation to assigned point values or ranges.
7. The software shall provide the ability to add custom gauges and charts to graphic pages.
8. The software must include a library of at least four hundred (400) standard control application graphics and symbols for visualizing common mechanical systems, including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams, piping, and laboratory symbols.
9. The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.
10. The Graphics application shall be capable of automatically assigning the appropriate symbol for an object (point) selected to be displayed on the graphic based on what the object represents (fan, duct sensor, damper, etc.) when the object is placed on a graphic.
11. The Graphics application shall allow a user to manually override the automatically assigned symbol for an object when a different symbol is desired.
12. The user shall have the ability to add custom symbols to the symbol library.
13. The software shall permit the importing of AutoCAD or scanned pictures for use in graphics.
14. Graphics must be automatically associated to any points or system objects that are rendered on the graphic, so that selection of a system object will allow a user to simply navigate to any associated graphic, without the need for manual association.
15. The software must allow users to command points directly off graphics application.
16. Graphic display shall include the ability to depict real-time point values dynamically with text or animation.
17. Navigation through various graphic screens shall be optionally achieved through a hierarchical "tree" structure
18. Graphics viewing shall include dynamic pan zoom capabilities.
19. Graphics viewing shall include the ability to switch between multiple layers with different information on each layer.
20. Graphics shall include a decluttering capability that allows layers to be programmatically hidden and displayed based on zoom level.
21. Graphics shall be capable of displaying the status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
22. The software must provide the ability to create dashboard views consisting of gauges and charts that graphically display system and/or energy performance.

G. System Performance:

1. Comply with the following performance requirements:
 - a. Graphic Display: Display graphic with minimum twenty (20) dynamic points with current data within 5 seconds.
 - b. Graphic Refresh: Update graphic with minimum twenty (20) dynamic points with current data within 5 seconds.
 - c. Object Command: Reaction time of less than 5 seconds between operator command of a binary object and device reaction.
 - d. Object Scan: Transmit change of state and change of analog values to control units or workstation within 5 seconds.
 - e. Alarm Response Time: Annunciate alarm at workstation within 2 seconds. Multiple workstations must receive alarms within 5 seconds of each other.
 - f. Program Execution Frequency: Programmable controllers shall execute DDC PI control loops, and scan and update process values and outputs at least once per second.
 - g. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - 1) Water Temperature: Plus or minus 1 deg F.
 - 2) Water Flow: Plus or minus five percent (+/-5%) of full scale.
 - 3) Water Pressure: Plus or minus two percent (+/-2%) of full scale.
 - 4) Space Temperature: Plus or minus 1 deg F.
 - 5) Ducted Air Temperature: Plus or minus 1 deg F.
 - 6) Outside Air Temperature: Plus or minus 2 deg F.
 - 7) Dew Point Temperature: Plus or minus 3 deg F.
 - 8) Temperature Differential: Plus or minus 0.25 deg F.
 - 9) Relative Humidity: Plus or minus two percent (+/-2%).
 - 10) Airflow (Pressurized Spaces): Plus or minus three percent (+/-3%) of full scale.
 - 11) Airflow (Measuring Stations): Plus or minus five percent (+/-5%) of full scale.
 - 12) Airflow (Terminal): Plus or minus ten percent (+/-10%) of full scale.
 - 13) Air Pressure (Space): Plus or minus 0.01-inch wg.
 - 14) Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - 15) Carbon Monoxide: Plus or minus five percent (+/-5%) of reading.
 - 16) Carbon Dioxide: Plus or minus 50 ppm.
 - 17) Electrical: Plus or minus five percent (+/-5%) of reading.

H. Reports:

1. The software must allow reports to be executed on demand.
2. The software must allow reports to be executed via pre-defined schedule.
3. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - a. A general listing of all or selected points in the network.
 - b. A status report showing present value and alarm status.
 - c. List of all points currently in alarm.
 - d. List of all points currently in override status.
 - e. List of all disabled points.
 - f. System diagnostic reports including, list of Building panels online and communicating, status of all Building terminal unit device points.
 - g. List of alarm strategy definitions.
 - h. List of Building Control panels.
 - i. Point totalization report.

- j. Point Trend data listings.
- k. Initial Values report.
- l. User activity report.
- m. Event history reports.

I. Scheduling:

1. The software shall provide a calendar type format for simplification of time and date scheduling and overrides of building operations.
2. The software shall support the definition of BACnet schedules that are defined at the workstation and are downloaded to Building Controller to ensure time equipment scheduling when PC is off-line, such that the operating software is not required to execute time scheduling. The software must provide the following capabilities for BACnet scheduling capabilities as a minimum:
 - a. Fully support all BACnet Schedule, Calendar, and Command objects.
 - b. Daily and Weekly schedules.
 - c. Ability to combine multiple points into a logical Command Groups for ease of scheduling (e.g., all Building 1 lights).
 - d. Ability to schedule for a minimum of up to ten (10) years in advance.
3. The software shall support the definition of schedules that are configured and executed to run at the workstation, to support scheduling of workstation software activities and to support field systems that do not include internal scheduling mechanisms. The software must provide the following capabilities for BACnet scheduling capabilities as a minimum:
 - a. Schedule pre-defined reports.
 - b. Schedule Trend collections.
 - c. Schedule automated system backups.
 - d. Schedule commands to be sent to field panels.
 - e. Daily and weekly schedules.
 - f. Setting up and executing Holiday schedules.
 - g. Ability to combine multiple points into a logical Command Groups for ease of scheduling (e.g., all Building 1 lights).
 - h. Ability to schedule for a minimum of up to ten (10) years in advance.
4. The software shall support the definition of **Apogee** Equipment Schedules Objects that are defined at the workstation and are downloaded to Building Controller to ensure time equipment scheduling when PC is off-line, such that the operating software is not required to execute time scheduling. The software must provide the following capabilities for BACnet scheduling capabilities as a minimum:
 - a. **Apogee** equipment schedule Zones.
 - b. **Apogee** equipment schedule Events.
 - c. Configuration of Daily, Weekly, Monthly schedules.
 - d. Configuration of Replacement Days.
5. The software shall provide the ability for users to override regular weekly schedules through menu selection, graphical mouse action, or function key.
6. The software shall provide a timeline view, showing the results of any number of combined selected workstation and field panel controller schedules for an overview of facility operation.

J. Trending:

1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time.
2. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable.
3. Trend data shall be collected and stored on hard disk for future diagnostics and reporting.
4. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of equipment.
5. System shall support trending in the same device as the monitor point or in an external device.
6. The software must support configuration of panels that have a trending level threshold, above which the data will be automatically uploaded to the BMS server to prevent overwriting the data in the field panel. The trending level will be user defined in percentage (%) of available space (e.g., automatically upload when the trend buffer is at seventy-five percent (75%) of allocated space).
7. Trend data reports shall be provided to allow the user to view all trended point data.
8. Trend data reports may be customized to include individual points or pre-defined groups of selected points.
9. The software shall allow the user to view real-time trend data on trend graphical plot displays.
 - a. A minimum of ten (10) points may be plotted.
 - b. A combination of real-time and historical data may be plotted.
 - c. Dynamic graphs shall continuously update point values.
 - d. At any time the user may redefine sampling times or range scales for any point.
 - e. The user may pause the display and take "snapshots" of plot screens to be stored on the workstation disk for future recall and analysis.
 - f. Exact point values may be viewed on the Trend plot.
 - g. Trend graphs may be printed.
 - h. Operator shall be able to command points by selecting them on the trend plot. Operator shall be able to zoom in on a specific time range within a plot.
 - i. The Trend Viewer must allow users to configure separate left and right axis for easier differentiation of point values.
 - j. The Trend Viewer must allow users to display historical data for the same group of points at different times simultaneously for easy comparison of system behavior over time.

K. Event Management:

1. Event Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each event: name, value, event time and date, event status, priority, acknowledgement information, and alarm count.
2. Only events for which the logged on user has privileges to view shall be displayed on each workstation.
3. The software shall provide the ability to users to limit the list of events displayed at each workstation (e.g. only show fire events at this workstation, no matter who is logged on).
4. Each event shall have the ability to sound an audible notification based on the category of the event.
5. Event List shall have the ability to list and sort the events based on event status, point name, ascending or descending activation time.
6. Directly from the Event List, the user shall have the ability to acknowledge, silence the event sound, print, or erase each event.
7. The interface shall provide the option to inhibit the erasing of active acknowledged events, until they have returned to normal status.
8. The user shall have the ability to navigate to all information related to a selected point in order to command, launch an associated graphic or trended graphical plot, or run a report on a selected point directly from the Event List.

9. Each event shall have a direct link from the Event List to further user-defined point informational data.
10. The user shall have the ability to also associate real-time electronic annotations or notes to each event.
11. Software shall provide the option to configure detailed operating procedures that guide a user through pre-determined standard operating procedures for handling critical events. Users shall be able to log completion of each operating step as it is performed.

L. External Data Access:

1. The software shall provide the ability to expose configuration properties and real-time values through CSV files, OPC DA, OPC UA, or REST-based Web Services.
2. The software shall provide the ability for external applications to change configuration and real-time values through OPC DA, OPC UA, or REST-based Web Services.
3. The software shall provide the ability for external applications to access historical Trend data through CSV files or REST-based Web Services.
4. External data access must be secured using the level of permissions configured for users and operator workstations.
5. Web service interfaces must allow for exchanging data (object's values, events and trend series) between workstation and external applications such as facility management systems, enterprise applications, mobile applications or other value-added services.
6. Documentation describing web services interfaces must be included to allow external developers to write applications that leverage the data exchange.

M. Licensing:

1. Software licensing must be allowed to be bound to a dongle or to physical PC hardware.
2. User licenses from all client types shall be from a common pool of client licenses. Licenses for installed and browser-based clients shall not be in separate pools.
3. Provide the number of client licenses as called for here or in the Sequence of Operations.

N. Data Security:

1. The BAS software must allow that all communication paths between clients and the server are encrypted and protected against replay attacks as well as data manipulation.
2. Any runtime data transfer between the system server and Web Server (IIS) must be allowed to be encrypted by Desigo CC.
3. Communication between any Web Server (IIS) and the Web Clients must be allowed to be encrypted.
4. Passwords must be handled with encrypted storage and transmission.
5. The software must support the use of public domain algorithms for cryptographic functions, including AES, DiffieHellmann, RSA, and SHA-2. No self-coded algorithms shall be allowed.
6. All symmetrical encryption must use 256-bit AES or stronger.
7. All asymmetrical encryption must use 2048-bit or stronger.
8. The software must support the use of commercial certificates for securing client-server communications.
9. The software must support the use of self-signed certificates to allow local deployments without the overhead of obtaining commercial certificates.
10. When using self-signed certificates, the owner of the Desigo CC system is responsible for maintaining their validity status, and for manually adding them to and removing them from the list of trusted certificates.
11. The BAS software shall be compatible with the following Virus Scanners:
 - a. Kaspersky
 - b. Avira

- c. McAfee
- d. Bitdefender
- e. TrendMicro Office Scan

O. Virtualization:

1. The BAS software must be compatible with following Virtualization software packages:
 - a. VMware®:
 - 1) Virtualization Platform: VSphere 6.0 or higher.
 - 2) Fault-tolerant Software: ESXi 6.0b managed by VCenter Server Appliance v6.0.0 or higher.
 - b. Stratus®:
 - 1) Virtualization Platform: KVM for Linux CentOS v7.0 or higher.
 - 2) Fault-tolerant Software: everRun Enterprise 7.2 or higher.
 - 3) Virtualization Platform: Citrix XenServer 6.0.2 or higher.
 - 4) Fault-tolerant Software: everRun MX 6.2 or higher.

P. Subsystem Connectivity:

1. The BAS application software must be capable of connecting simultaneously to multiple control systems and data sources.
2. Interface software shall simultaneously communicate with and share data between multiple Ethernet-connected building level networks.
3. The BAS application software must support the following standard protocols:
 - a. BACnet IP (standard Revision 1.13)
 - b. OPC (OLE for Process Control) OPC DA 2.05, 3.0
 - c. Modbus TCP
 - d. SNMP (Agent V1 and V2)
 - e. Siemens Apogee P2
 - f. Siemens XNET
4. Any break in system controller communication must result in a notification at the server.

Q. BACnet:

1. The Operator Workstation Software shall be capable of BACnet IP communications.
2. The Operator Workstation Software shall have demonstrated interoperability during at least one (1) BTL Interoperability Workshop.
3. The Operator Workstation Software shall have demonstrated compliance to BTL B-AWS device classification through BTL listing as specified in ANSI/ASHRAE 135 under revision 1.13 or higher.
4. The BAS software shall meet the BACnet device profile of an Advanced Workstation Server (B-AWS) and Operator Workstation (B-OWS) and shall support the following BACnet BIBBs:
 - a. Data Sharing:
 - 1) DS-RP-A Data Sharing-ReadProperty-A
 - 2) DS-RP-B Data Sharing-ReadProperty-B
 - 3) DS-RPM-A Data Sharing-ReadPropertyMultiple-A

- 4) DS-RPM-B Data Sharing-ReadPropertyMultiple-B
- 5) DS-WP-A Data Sharing-WriteProperty-A
- 6) DS-WP-B Data Sharing-WriteProperty-B
- 7) DS-WPM-A Data Sharing-WritePropertyMultiple-A
- 8) DS-COV-A Data Sharing-ChangeofValue-A
- 9) DS-COVP-A Data Sharing – ChangeofValueProperty-A
- 10) DS-V-A Data Sharing - View – A
- 11) DS-AV-A Data Sharing - Advanced View – A
- 12) DS-M-A Data Sharing - Modify – A
- 13) DS-AM-A Data Sharing - Advanced Modify – A

b. Scheduling:

- 1) SCHED-VM-A Scheduling-View and Modify-A
- 2) SCHED-AVM-A Scheduling-Advanced View and Modify-A
- 3) SCHED-WS-A Scheduling-Weekly Schedule-A

c. Alarm and Event Management:

- 1) AE-N-A Alarm and Event-Notification-A
- 2) AE-ACK-A Alarm and Event-ACK-A
- 3) AE-LS-A Alarm and Event-LifeSafety – A
- 4) AE-VM-A Alarm and Event Management - View and Modify – A
- 5) AE-AVM-A Alarm and Event Management - Advanced View and Modify – A
- 6) AE-VN-A Alarm and Event Management - View Notifications – A
- 7) AE-AVN-A Alarm and Event Management - Advanced View Notifications – A

d. Trending:

- 1) T-V-A Trending-Viewing and Modifying Trends-A
- 2) T-ATR-A Trending-Automated Trend Retrieval-A
- 3) T-AVM-A Trending-Advanced View and Modify -A

e. Network Management: NM-CE-A Network Management-Connection Establishment-A

f. Device Management:

- 1) DM-DDB-A Device Management-Dynamic Device Binding-A
- 2) DM-DDB-B Device Management-Dynamic Device Binding-B
- 3) DM-DOB-A Device Management-Dynamic Object Binding-A
- 4) DM-DOB-B Device Management-Dynamic Object Binding-B
- 5) DM-DCC-A Device Management-DeviceCommunicationControl-A
- 6) DM-TM-A Device Management-Text Message-A
- 7) DM-MTS-A Device Management-Manual Time Synchronization-A
- 8) DM-ATS-A Device Management-Automatic Time Synchronization-A
- 9) DM-TS-A Device Management-TimeSynchronization-A
- 10) DM-UTC-A Device Management-UTCTimeSynchronization-A
- 11) DM-RD-A Device Management-ReinitializeDevice-A
- 12) DM-BR-A Device Management-Backup and Restore-A
- 13) DM-LM-A Device Management-List Manipulation-A
- 14) DM-LM-B Device Management-List Manipulation-B
- 15) DM-OCD-A Device Management-Object Creation and Deletion-A
- 16) DM-ANM-A Device Management-Automatic Network Mapping-A
- 17) DM-ADM-A Device Management-Automatic Device Mapping-A

5. The BAS Server and Workstations shall support the following Data Link Layers:
 - a. BACnet IP Annex J
 - b. BACnet IP Annex J Foreign Device
 - c. ISO 8802-3, Ethernet (Clause 7)
6. The BAS Server and Workstations shall be able to interact with all the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
 - a. Calendar – Creatable, Deletable
 - b. Command – Creatable, Deletable
 - c. Event Enrollment – Creatable, Deletable
 - d. Notification Class – Creatable, Deletable
 - e. Schedule - Creatable, Deletable
7. The BAS Server and Workstations shall support transmitting and receiving segmented messages.
8. The BAS Server and Workstation shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.

2.5 DIRECT DIGITAL CONTROLLER SOFTWARE

- A. Provide a full capability user license to the Owner for the operator to be able to see, modify, create, upload, download, and save control programs to the DDC controllers.
- B. The software program shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher-level computer or another controller for execution.
- C. The software shall be provided with an interactive HELP function to assist operators with syntax, abbreviations, commands, and saving programs.
- D. Point Naming and Communication Format:
 1. All points, panels, and programs shall be identified by a 30-character name. All points shall also be identified by a 16-character point descriptor. The same names shall be displayed at both Building Controller and the Operator Interface.
 2. All digital points shall have a consistent, user-defined, two-state status indication with eight (8) characters minimum (e.g., Summer, Enabled, Disabled, Abnormal).
 3. The Building Controller Software shall be capable of BACnet communications. The BACnet Building Controller (B-BC) shall have demonstrated interoperability during at least one (1) BTL Interoperability Workshop, have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, Annex L.
- E. System Security:
 1. User access shall be secured using individual security passwords and usernames.
 2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
 3. Building Controllers shall be able to assign a minimum of fifty (50) passwords access and control priorities to each point individually. The logon password (at any Operator Interface or portable operator terminal) shall enable the operator to monitor, adjust, and control only the points that the operator is authorized for. All other points shall not be displayed

- at the Operator Interface or portable terminal. Passwords and priorities for every point shall be fully programmable and adjustable.
4. User Log On/Log Off attempts shall be recorded.
 5. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
 6. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the DDC controller software.
- F. User Defined Control Applications: The applications software shall program DDC routines to meet the sequences of operations.
1. Building Controllers shall have the ability to perform energy management routines including but not limited to time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating/cooling interlock, supply temperature reset, priority load shedding, and power failure restart.
 2. The Building Controllers shall have the ability to perform the following pre-tested control algorithms:
 - a. Two-position with differential control and time delays.
 - b. Floating control.
 - c. Proportional control.
 - d. Proportional plus integral control.
 - e. Proportional, integral, plus derivative control.
 - f. Automatic tuning of control loops.
 - g. Model-free adaptive control.
 - h. Start Stop Time Optimization.
 3. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
 4. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
- G. Peer-To-Peer Access to Other DDC Controllers:
1. It shall be possible to use any actual or virtual point data or status, any system calculated data, a result from any process, or any user-defined constant in any controller in the system.
 2. Any process shall be able to issue commands to points in any and all other controllers in the system.
 3. Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of an advanced annunciation feature, such as:
 - a. Generate a report.
 - b. Annunciate an alarm.
 - c. Issue a text message or email.
- H. Alarm Management:
1. Alarm management shall be provided within the controller software to monitor and direct alarm information to operator devices.

2. Each Building Controller shall perform distributed, independent alarm analysis, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
3. Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.
4. An Alarm "shelving" feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).
5. Binary Alarms. Each binary alarm object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
6. Analog Alarms. Each analog alarm object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
7. All alarm shall include the point's user-defined language description and the time and date of occurrence.
8. Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print reports, be logged in the event log, generate custom messages, and display graphics.
9. The user shall be able to add a 200-character alarm message to each alarm point to more fully describe the alarm condition or direct operator response. Each Building Controller shall be capable of storing a library of at least fifty (50) alarm messages. Each message may be assigned to any number of points in the Controller.
10. Operator-selected alarms shall be capable of initiating a trigger to an advanced annunciation, such as text, email, etc.
11. An alarm history log shall report the start of the alarm condition, acknowledgement by a user and return of the alarm to normal condition.

I. Scheduling:

1. Provide a comprehensive menu driven program to automatically start and stop designated multiple objects or events in the system according to a stored time.
2. Schedules shall reside in the building controller and shall not rely on external processing or network.
3. It shall be possible to define a group of objects as a custom event (i.e., meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.
4. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and/or stop within that group.
5. The operator shall be able to define the following information:
 - a. Time, day.
 - b. Commands such as on, off, auto, etc.
 - c. Time delays between successive commands.
 - d. There shall be provisions for manual overriding of each schedule by an authorized operator.
6. It shall be possible to schedule calendar-based events up to one (1) year in advance based on the following:
 - a. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.
 - b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a

year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.

J. Peak Demand Limiting (PDL):

1. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
2. PDL shall continuously track the amount of electricity being consumed, by monitoring one (1) or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
3. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
4. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user pre-set maximum allowable level, then PDL shall automatically shed electrical loads.
5. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.

K. Temperature-Compensated Duty Cycling:

1. User defined conditions shall be able to initiate a Duty Cycle Control Program.
2. The Duty Cycle Control Program (DCCP) shall be configured to periodically stop and start loads according to various patterns.
3. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.

L. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.

M. Night Setback Control: The system shall provide the ability to automatically adjust setpoints for night control.

N. Enthalpy Switchover (Economizer): The Building Controller Software (BCS) shall control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover setpoint the BCS will modulate the dampers to provide one hundred percent (100%) outside air. The user will be able to quickly change over to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.

O. Control Loop Algorithm: Provide a PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and weighting parameters shall be accessible from the operator workstation.

P. Adaptive Loop Tuning:

1. Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned control loop performance shall be provided on a monthly, seasonal, quarterly, annual period.
2. For Model-Free Adaptive Control loops, evidence of tuned control loop performance shall be provided via graphical plots or trended data logs. Graphical plots shall minimally include depictions of setpoint, process variable (output), and control variable (e.g., temperature). Other parameters that may influence loop control shall also be included in the plot (e.g., fan on/off, mixed-air temp).

3. For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.
 - a. In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.
 - b. Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
- Q. Logic Programming: Provide a software routine that can build ladder logic to control using many conditional statements.
1. The logic programming syntax shall be able to combine ladder logic with other software features, such as combining status, scheduling, PDL and alarm conditions into one (1) conditional decision.
 2. Logic programming shall be able to reference conditions in any other controller in the system.
- R. Staggered Start:
1. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable in an application and shall not require written scripts or ladder logic.
 2. Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.
- S. Totalization Features:
1. Run-Time Totalization: Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
 2. Consumption Totalization: Building Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.
 3. Event Totalization: Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.
- T. Data Collection:
1. A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for all points.
 2. Building Controllers shall store point history data for selected analog and digital inputs and outputs.
 3. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Building Controllers point group.

4. Two (2) methods of collection shall be allowed: either by up to four (4) pre-defined time intervals or upon a pre-defined change of value. Sample intervals of 1 minute to seven (7) days shall be provided.
5. Each Building Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of ten thousand (10,000) data samples.
6. Trend data shall be stored at the Building Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in third-party personal computer applications.

2.6 BACNET BUILDING CONTROLLERS

- A. Provide all necessary hardware for a complete operating system as required. The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher-level computer or another controller for operation.
- B. Basis-of-Design: Siemens **PX Modular and Compact Controllers (PXC)**
- C. This controller shall have the BTL listing and meet the BACnet device profile of a Building Controller (B-BC) and shall support the following BACnet BIBBs:
 1. Data Sharing:
 - a. Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)
 - b. Data Sharing-Read Property Multiple- Initiate, Execute (DS-RPM-A,B)
 - c. Data Sharing-Write Property- Initiate, Execute (DS-WP-A,B)
 - d. Data Sharing-Write Property Multiple- Execute (DS-WPM-B)
 - e. Data Sharing-COV- Initiate, Execute (DS-COV-A,B)
 - f. Data Sharing-COV-Unsolicited- Initiate, Execute (DS-COVU-A,B)
 2. Scheduling:
 - a. Scheduling-Internal- Execute (SCHED-I-B)
 - b. Scheduling-External- Execute (SCHED-E-B)
 3. Trending:
 - a. Trending-Viewing and Modifying Trends - Initiate (T-VMT-A)
 - b. Trending-Viewing and Modifying Trends Internal- Execute (T-VMT-I-B)
 - c. Trending-Viewing and Modifying Trends-External- Execute (T-VMT-E-B)
 - d. Trending-Automated Trend Retrieval- Execute (T-ATR-B)
 4. Network Management: Network Management-Connection Establishment- Initiate (NM-CE-A)
 5. Alarming:
 - a. Alarm and Event-Notification- Initiate (AE-N-A)
 - b. Alarm and Event-Notification Internal- Execute (AE-N-E-B)
 - c. Alarm and Event-Notification External- Execute (AE-N-E-B)
 - d. Alarm and Event-ACK- Initiate, Execute (AE-ACK-A,B)
 - e. Alarm and Event –Alarm Summary- Execute (AE-ASUM-B)
 - f. Alarm and Event –Enrollment Summary- Execute (AE-ESUM-A,B)
 - g. Alarm and Event –Information- Initiate, Execute (AE-ESUM-A,B)
 6. Device Management:

- a. Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A,B)
 - b. Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)
 - c. Device Management-Device Communication Control- Execute (DM-DCC-B)
 - d. Device Management-Private Transfer- Initiate, Execute (DM-PT-A,B)
 - e. Device Management-Text Message- Initiate, Execute (DM-TM-A,B)
 - f. Device Management-Time Synchronization- Execute (DM-TS-B)
 - g. Device Management-Reinitialize Device- Execute (DM-RD-B)
 - h. Device Management-Backup and Restore- Execute (DM-RD-B)
 - i. Device Management-List Manipulation- Execute (DM-RD-B)
 - j. Device Management-Object Creation and Deletion- Execute (DM-OCD-B)
7. The Building Level Controller shall support the following Data Link Layers:
- a. BACnet IP Annex J
 - b. BACnet IP Annex J Foreign Device
 - c. MS/TP Master (Claus 9)
8. The Building Level Controller shall be able to interact with all the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
- a. Calendar – Creatable, Deletable
 - b. Command – Creatable, Deletable
 - c. Event Enrollment – Creatable, Deletable
 - d. Notification Class – Creatable, Deletable
 - e. Schedule - Creatable, Deletable
9. The Building Level Controller shall support transmitting and receiving segmented messages.
10. The Building Level Controller shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.
11. The Building Level Controller shall have the capability to act as a BACnet router between MS/TP subnetworks and BACnet/IP.
- D. This level of controller shall be used for the following types of systems:
1. Chiller plant systems.
 2. Heating plant systems.
 3. Cooling towers.
 4. Pumping systems.
 5. VAV air handlers.
 6. Air handlers over 15,000 cfm.
 7. Systems with over twenty-four (24) input/output points.
 8. Rooftop systems.
- E. Computing Power and Memory Minimum:
1. A 32-bit, stand-alone, multi-tasking, multi-user, real-time 100MHz digital control microprocessor module.
 2. Inputs shall be 16-bit minimum analog-to-digital resolution.
 3. Outputs shall be 10-bit minimum digital-to-analog resolution
 4. Memory module (24 Megabyte, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases (see Controllers Software section), including control processes, energy management applications, alarm management applications, historical/trend data for

- points specified, maintenance support applications, custom processes, operator I/O, dial-up communications.
 - 5. Real time clock and battery.
 - 6. Data collection/data Trend module sized for ten thousand (10,000) data samples.
 - 7. Flash Memory Firmware: Each Building Level Control Panel shall support firmware upgrades without the need to replace hardware.
- F. Onboard or Modular Hardware and Connections:
- 1. Primary Network communication module, if needed for primary network communications.
 - 2. Secondary Network communication module, if needed for secondary network communications.
 - 3. RJ45 port 10/100Mbaud.
 - 4. RS485 ports for subnetworks and point expansion.
 - 5. Man to Machine Interface port (MMI).
 - 6. USB Port.
- G. Input and Output Points Hardware:
- 1. Input/output point modules as required including spare capacity.
 - 2. Input/output point modules shall have removable terminal blocks.
 - 3. Monitoring of the status of all hand-off-auto switches.
 - 4. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
 - 5. Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
 - 6. Graduated intensity LEDs or analog indication of value for each analog output.
- H. Code Compliance:
- 1. Approvals and Standards: UL916; CE; FCC
 - 2. Provide UL864-UUKL where called for in the sequences of operations.
- I. Accessories:
- 1. Appropriate NEMA rated metal enclosure.
 - 2. Power supplies as required for all associated modules, sensors, actuators, etc.
- J. The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on-board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. Provide hand/off/auto switch for each digital output, including spares.
- K. Each Building Level Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.
- L. Panel setup, point definitions, and sequencing diagrams shall be backed up on EEPROM memory.

- M. Power Loss: In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of thirty (30) days.
- N. Building Level control panels shall provide at least two serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal communications, operation of permanently connected modems, printers or terminals.
- O. Building Level Controllers shall have the capability to serve as a gateway between Modbus subnetworks and BACnet objects. Provide software, drives and programming.
- P. Isolation shall be provided at all primary control panel terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.
- Q. Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on Drawings and ten percent (10%) more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.
- R. Environment:
 - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 2. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 32°F to 120°F.
 - 3. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 32°F to 120°F.
 - 4. Controller hardware shall be optionally suitable for rooftop environments.
- S. Immunity to Power and Noise:
 - 1. Controller shall be able to operate at ninety to one hundred ten percent (90-110%) of nominal voltage rating and shall perform an orderly shutdown below eighty percent (80%) nominal voltage.
 - 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
 - 3. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 - a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.
 - b. Electrostatic Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
 - c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
 - d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
 - 4. Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:
 - a. IEEE Standard 587 1980
 - b. UL 864 Supply Line Transients
 - c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

2.7 BACNET ADVANCED APPLICATION CONTROLLERS

- A. Provide all necessary hardware for a complete operating system as required. The Advanced Application level control panel shall be able to operate as a standalone panel and shall not be dependent upon any higher-level computer or another controller for operation.
- B. Basis-of-Design: Unitary Equipment Controller (**PXCxx-UCM**)
- C. The Advanced Application Controller Software shall be capable of BACnet communications. The BACnet Advanced Application Controller (B-AAC) shall have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004 or ANSI/ASHRAE 135-2008. Supported BIBBS shall include:
 - 1. Data Sharing:
 - a. Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)
 - b. Data Sharing-Read Property Multiple- Initiate, Execute (DS-RPM-A,B)
 - c. Data Sharing-Write Property- Initiate, Execute (DS-WP-A,B)
 - d. Data Sharing-Write Property Multiple- Execute (DS-WPM-B)
 - e. Data Sharing-COV- Initiate, Execute (DS-COV-A,B)
 - 2. Scheduling: Scheduling-Internal- Execute (SCHED-I-B)
 - 3. Trending:
 - a. Trending-Viewing and Modifying Trends Internal- Execute (T-VMT-I-B)
 - b. Trending-Automated Trend Retrieval- Execute (T-ATR-B)
 - 4. Network Management: Network Management-Connection Establishment- Initiate (NM-CE-A)
 - 5. Alarming:
 - a. Alarm and Event-Notification Internal- Execute (AE-N-I-B)
 - b. Alarm and Event-ACK- Initiate, Execute (AE-ACK-A,B)
 - c. Alarm and Event –Enrollment Summary- Execute (AE-ESUM-B)
 - d. Alarm and Event –Information- Execute (AE-INFO-B)
 - 6. Device Management:
 - a. Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A,B)
 - b. Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)
 - c. Device Management-Device Communication Control- Execute (DM-DCC-B)
 - d. Device Management-Time Synchronization- Execute (DM-TS-B)
 - e. Device Management-Reinitialize Device- Execute (DM-RD-B)
 - f. Device Management-Backup and Restore- Execute (DM-BR-B)
 - g. Device Management-List Manipulation- Execute (DM-LM-B)
 - h. Device Management-Object Creation and Deletion- Execute (DM-OCD-B)
 - 7. The Advanced Application Controller shall be able to interact with all the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
 - a. Calendar – Creatable, Deletable
 - b. Command – Creatable, Deletable
 - c. Event Enrollment – Creatable, Deletable

- d. Notification Class – Creatable, Deletable
 - e. Schedule - Creatable, Deletable
- 8. The Advanced Application Controller shall support transmitting and receiving segmented messages.
- D. Communication:
 - 1. BAS Network: The Advanced Application Controller shall support the following Data Link Layers:
 - a. MS/TP Master
 - 2. Serial Communication: Temporary use of portable devices shall not interrupt the BAS communication, nor the normal operation of permanently connected printers or terminals.
 - a. Provide at least one (1) EIA-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals.
 - b. A USB port shall alternatively be available to support local HMI tools connection.
- E. Software:
 - 1. The software programs specified in this section shall be provided as an integral part of Advanced Application Controllers and shall not be dependent upon any higher-level computer or another controller for execution.
 - 2. Advanced Application Controllers shall have the ability to perform energy management routines including but not limited to
 - a. Scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides.
 - b. Automatic daylight savings time switch over.
 - c. Night setback control.
 - d. Economizer switch over using enthalpy, dry bulb, or a combination.
 - e. Peak demand limiting.
 - f. Temperature-compensated duty cycling.
 - g. Heating/cooling interlock.
 - h. Supply temperature reset.
 - i. Priority load shedding.
 - j. Power failure restart.
 - 3. The software shall have a routine for automatic tuning of control loops.
 - 4. System Security in the Field Panel:
 - a. User access shall be secured using individual security passwords and usernames.
 - b. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
 - c. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
 - d. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the field panel.
 - 5. User Defined Control Applications:

- a. Controllers shall be fully-programmable. Controllers shall execute custom, job-specific sequences to automatically perform calculations and special control routines. Factory installed or pre-configured sequences shall only be allowed if they exactly match the sequence specified herein.
- b. Programs shall combine control logic, control loop algorithms, and energy management routines.
- c. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
- d. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task-oriented information from the user manual.

F. Adaptive Loop Control:

- 1. Each AAC controller shall come standard with an Adaptive Control Loop Algorithm:
 - a. Tuning parameter shall automatically adjust for non-linear applications.
- 2. Model-Free Adaptive (MFA) Algorithm:
 - a. The algorithm shall not require modeling of the non-linear system in order to maintain control at all points of the non-linear load.
 - b. The controlled variable, setpoint, and weighting parameters shall be user-selectable.
- 3. Output shall be analog or shall stage a series of outputs.
- 4. Adaptive Control shall take the place of Proportional, Proportional + Integral, and PID type algorithms for non-linear applications. Adaptive Control routines shall:
 - a. Improve response time.
 - b. Improve system efficiency.
 - c. Improve stability.
 - d. Result in consistent outputs.
 - e. Reduce cycling and repositioning.
 - f. Reduce wear and tear on actuators.
- 5. Adaptive control shall auto-adjust to compensate for:
 - a. Mode changes.
 - b. Load changes.
 - c. Seasonal changes.
 - d. Heating and cooling changeover.
 - e. Heating or cooling capacity changes on the primary side.
 - f. Flow changes on the primary or secondary side.
 - g. Airflow changes across coil.
 - h. Flow across a heat exchanger.
 - i. Non-linear coils and heat exchangers.
 - j. Hot water and chilled water reset routines.
 - k. Water flow reset routines.
 - l. Duct Static reset routines.
- 6. Auto-Tune PID loops are not acceptable substitutions.
- 7. If Adaptive Loop Control is not available, then the BAS contractor shall provide re-tuning of the control loops for coils and heat exchangers for each of the following conditions:

- a. Low heating supply water, high heating supply water.
- b. Low load on steam coil, high load on steam coil.
- c. Chilled water coil, non-dehumidification and condensing.
- d. Chilled water coil, low airflow, high airflow, economizer.
- e. Dual temperature systems tune for heating and cooling modes.
- f. Each of four (4) seasons.

G. This level of controller shall be used for the following types of systems:

1. Systems with custom sequences that meet all the criteria below.
2. No primary pumping systems.
3. Secondary pumping systems that are remote from Central Plants.
4. Air handlers up to 15,000 cfm.
5. Systems up to twenty (20) input/output points.
6. Room control sequences that cannot be achieved with an application specific controller.
7. BAS Network or Architecture or Sequences do not require the system to be on an IP network.
8. No systems that require integration to meters, VFDs or other smart equipment.
9. Integration to smart thermostats is allowed.

H. Input/Outputs:

1. Inputs shall be 16-bit minimum digital resolution.
2. Outputs shall be 10-bit minimum digital resolution.
3. The following I/O port types shall be available on the controller:
 - a. Universal Input (Software Configurable):
 - 1) Digital Input Choices:
 - a) Pulse Accumulator
 - b) Contact Closure Sensing
 - c) Dry Contact/Potential Free inputs only
 - d) Digital Input (10 ms settling time)
 - e) Counter inputs up to 20 Hz, minimum pulse duration 20 ms (open or closed)
 - 2) Analog Input Choices:
 - a) 0-10 Vdc
 - b) 4-20 mA
 - c) 1K Ni RTD @ 32°F (Siemens, JCI, DIN Ni 1K)
 - d) 1K Pt RTD (375 or 385 alpha) @ 32°F
 - e) 10K NTC Type 2 or Type 3 Thermistor
 - f) 100K NTC Type 2 Thermistor
 - b. Universal Input or Output (Software Configurable):
 - 1) All the above input types.
 - 2) Analog Output Types: 0 to 10 Vdc @ 1 mA max
 - c. Super Universal Input or Output (Software Configurable):
 - 1) All the above input types.
 - 2) All the above output types.

- 3) Super Digital Output Type: 0 to 24 Vdc, 22 mA max. (for controlling pilot relay)
 - 4) Super Analog Output Choices: 0 to 20 mA @ 650 Ω max.
4. Provide software configurable I/O ports such that a programmer make a port either an input or an output.
- I. Each System Level Control Panel shall, at a minimum, be provided with:
1. Appropriate NEMA rated metal enclosure.
 2. A 32-bit, multi-tasking, real-time 100 MHz digital control microprocessor with plug-in, enclosed processors.
 3. Each Advanced Application Controller shall have sufficient memory, a minimum of 24 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, and operator I/O.
 4. Real time clock and battery.
 5. Data collection/data Trend module sized for ten thousand (10,000) data samples.
 6. Power supplies as required for all associated modules, sensors, actuators, etc.
 7. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
 8. Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
 9. Each control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
 10. Graduated intensity LEDs or analog indication of value for each analog output.
- J. Power Loss: In the event of the loss of power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for the operating system software and firmware.
1. Controller shall be able to operate at ninety to one hundred ten percent (90-110%) of nominal voltage rating and shall perform an orderly shutdown below eighty percent (80%) nominal voltage.
 2. Brownout protection and power recovery circuitry protect the controller board from power fluctuations.
 3. Battery backup shall be provided to support the real-time clock for ten (10) years.
 4. The program and database information stored SDRAM memory shall be battery backed for a minimum of thirty (30) days and up to sixty (60) days. This eliminates the need for time consuming program and database re-entry in the event of an extended power failure.
- K. Database Restore: Each AAC controller shall automatically save the latest programmed database. The controller shall be able to automatically restore a lost or corrupt database without involvement from the operator.
- L. Each System Level Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.
- M. Each Control Panel shall support firmware upgrades without the need to replace hardware.

- N. System Level control panels shall provide at least two (2) RS-232C serial data communication ports for operation of operator I/O devices such as operator terminals, and additional memory. Control panels shall allow temporary use of portable operator interface devices without interrupting the normal communications.
- O. Immunity to Noise:
1. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
 2. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 - a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.
 - b. Electrostatic Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
 - c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
 - d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
 3. Isolation shall be provided at all Advanced Application Controller's AC input terminals to suppress induced voltage transients consistent with:
 - a. IEEE Standard 587 1980
 - b. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)
- P. Agency Compliance:
1. UL UL916 PAZX (all models)
 2. UL916 PAZX7 (all models)
 3. FCC Compliance CFR47 Part 15, Subpart B, Class B
- Q. Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on Drawings and ten percent (10%) more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

2.8 CONTROL PANELS

- A. Controllers in mechanical rooms shall be mounted in NEMA 1 enclosures.
- B. Controllers in areas where moisture is a concern shall be mounted in NEMA 12 enclosures.
- C. Controllers installed outdoors shall be mounted in NEMA 4X enclosures. Provide heaters where freezing temperatures are normally experienced.
- D. Mount on walls at an approved location or provide a free-standing rack.
- E. Panels shall be constructed of 16-gauge, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with ANSI 61 gray polyester-powder painted finish, UL listed. Provide common keying for all panels.
- F. Provide power supplies for control voltage power.

- G. Dedicate one (1) power supply to the DDC controller. Other devices shall be on a separate power supply, unless the power for the control device is derived from the controller terminations.
- H. Power supplies for controllers shall be a transformer with a fuse or circuit breaker. Power supplies for other devices can be plain transformers.
- I. All power supplies for 24V low voltage wiring shall be class 2 rated and less than 100VA. If low voltage devices require more amps, then provide multiple power supplies. If a single device requires more amps, then provide a dedicated power supply in a separate enclosure and run a separate, non-class 2 conduit to the device.
- J. Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.
- K. All devices in a panel shall be permanently mounted, including network switches, modems, media converters, etc.
- L. Provide a pocket to hold documentation.

2.9 UNINTERRUPTIBLE POWER SUPPLY

- A. Provide an UPS for each of the following: BAS Server.
- B. Each UPS shall power the device for a minimum of 30 minutes, in the case of power interruption.
- C. The UPS shall be DIN rail mounted within the associated control panel and consist of a battery power source, charger, AC output inverter system, and automatic load transfer circuits for a full automatic operation. The UPS shall be an on-line type. When normal AC power returns, the UPS shall transfer the load to the rectifier output. At this time, the charger shall turn on to its 'high' charge rate until the batteries are charged approximately eighty percent (80%) of their rated capacity and then automatically shall switch to its maintenance 'sensing' position to keep the batteries in their best full-charge condition. Battery recharge time shall not be more than 3 hours.
- D. Each UPS shall be provided, as a minimum, with pilot lights for the following conditions: "Incoming AC Power is Available", "UPS Ready Mode", and "UPS in Standby Mode". The UPS shall have the capability to hot-swap batteries without interrupting the supply of power to its users.
- E. The batteries shall be of the totally enclosed nickel-cadmium type or equal. Batteries that can leak gas shall not be acceptable. There shall not be any damage should the emergency outage of line power exceed the maximum operation time of the UPS. Automatic shutdown shall occur when the UPS' maximum duty cycle is exceeded.
- F. Provide APC, Liebert, or pre-approved equal.

2.10 SENSORS

- A. General:
 - 1. Provide mounting hardware for all devices, including actuator linkages, wells, installation kits for insertion devices, wall boxes and fudge plates, brackets, etc.
 - 2. If a special tool is required to mount a device, provide that tool.

B. Terminal Unit Space Thermostats:

1. Each controller performing space temperature control shall be provided with a matching room temperature sensor.
2. Plain Space Temperature Sensors – Wired: Where called for in the sequences or on the Drawings, provide sensors with plain covers.
 - a. The sensing element for the space temperature sensor shall be thermistor type providing the following:
 - 1) Element Accuracy: + /- 1.0°F.
 - 2) Operating Range: 55 to 95°F.
 - 3) Set Point Adjustment Range: 55 to 95°F.
 - 4) Calibration Adjustments: None required.
 - 5) Installation: Up to 100 feet from controller.
 - 6) Auxiliary Communications Port: As required.
 - 7) Local LCD Temperature Display: As required.
 - 8) Setpoint Adjustment Dial: As required.
 - 9) Occupancy Override Switch: As required.
 - b. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.
3. Digital Display Temperature Sensor Specifications – Wired: As called for in the sequences of operations or on the Drawings, provide temperature sensors with digital displays.
 - a. The sensing element for the space temperature sensor must be IC-based and provide the following:
 - 1) Digitally communicating with the Application Specific Controller.
 - 2) Mountable to and fully covering a 2 x 4 electrical junction box without the need for an adapter wall plate.
 - 3) IC Element Accuracy: +/- 0.9°F.
 - 4) Operating Range: 55 to 95°F.
 - 5) Setpoint Adjustment Range: User limiting, selectable range between 55 and 95°F.
 - 6) Display of temperature setpoint with numerical temperature values.
 - 7) Display of temperature setpoint graphically, with a visual Hotter/Colder setpoint indication.
 - 8) Calibration: Single point, field adjustable at the space sensor to +/- 5°F.
 - 9) Installation: Up to 100 feet from controller.
 - 10) Auxiliary Communications Port: Included.
 - 11) Local OLED Temperature Display: Included.
 - 12) Display of temperature to one (1) decimal place.
 - 13) Temperature Setpoint Adjustment: Included.
 - 14) Occupancy Override Function: Included.
 - b. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall

allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.

4. Provide the following options as they are called for in the sequences or on the Drawings:
 - a. Setpoint Adjustment. The setpoint adjustment function shall allow for modification of the temperature by the building operators. Setpoint adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.
 - b. Override Switch. An override button shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to 2 hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.
 - c. Space Combination Temperature and Humidity Sensors. Each controller performing space temperature control shall be provided with a matching room temperature sensor, which also includes the ability to measure humidity for either monitoring or control purposes. The combination temperature and humidity sensors shall have the same appearance as the space temperature sensors. Humidity elements shall measure relative humidity with a plus or minus two percent (+/-2%) accuracy over the range of ten to ninety percent (10-90%) relative humidity. Humidity element shall be an IC (integrated circuit) sensing element. Humidity sensing elements shall be removable and field replaceable if needed.

C. Temperature Sensors:

1. All temperature sensors shall meet the following specifications:
 - a. Accuracy: Plus or minus 0.2 percent at calibration point.
 - b. Wire: Twisted, shielded-pair cable.
 - c. Vibration and corrosion resistant.
2. Space temperature sensors shall meet the following specifications: 10k ohm type 2 thermistors.
3. Insertion Elements in Ducts shall meet the following specifications:
 - a. Single point 10k ohm thermistor.
 - b. Use where not affected by temperature stratification.
 - c. The sensor shall reach more than 1/3 the distance from the duct wall.
 - d. Junction box for wire splices.
4. Averaging Elements in Ducts shall meet the following specifications:
 - a. 72 inches long.
 - b. Flexible.
 - c. Use where prone to temperature stratification, in front of coils, or where ducts are larger than 9 sq. ft.
 - d. Junction box for wire splices.
5. Insertion Elements for Liquids shall meet the following specifications:
 - a. Platinum RTD with 4-20mA transmitter.
 - b. Threaded mounting with matching well.

- c. Brass well with minimum insertion length of 2½ inches for pipes up to 4-inch-diameter.
 - d. Brass well with insertion length of 6 inches for pipes up to 10-inch-diameter.
 - e. Junction box for wire splices.
- 6. Outside-Air Sensors Platinum RTD with 4-20mA transmitter:
 - a. Watertight enclosure, shielded from direct sunlight.
 - b. Circulation fan.
 - c. Watertight conduit fitting.
- D. Where called for in the sequences of operations, provide the following feature on space sensors and thermostats:
 - 1. Security Sensors: Stainless-steel cover plate with insulated back and security screws.
 - 2. Space Sensors with Setpoint Adjust: Plain white plastic cover with slide potentiometer to signal a setpoint adjustment to the DDC.
 - 3. Space Sensors with LCD display:
 - a. Operator buttons for adjusting setpoints, setting fans speeds and overriding unit to on/off.
 - b. Graphical LCD icons for signaling heating/cooling mode, fans speed, schedule mode, actual temperature, and current setpoint.
- E. Humidity Sensors shall meet the following specifications:
 - 1. Bulk polymer sensor element.
 - 2. Accuracy: Two percent (2%) full range with linear output.
 - 3. Room Sensors: With locking cover matching room thermostats, span of zero to one hundred percent (0-100%) relative humidity.
 - 4. Duct and Outside-Air Sensors: With element guard and mounting plate, range of zero to one hundred percent (0-100%) relative humidity.
- F. Air Static Pressure Transmitter shall meet the following specifications:
 - 1. Non-directional sensor with suitable range for expected input, and temperature compensated.
 - 2. Accuracy: Two percent (2%) of full scale with repeatability of 0.5 percent.
 - 3. Output: 4 to 20 mA.
 - 4. Building Static-Pressure Range: 0 to 0.25 inches wg.
 - 5. Duct Static-Pressure Range: 0 to 5 inches wg.
- G. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.
- H. Equipment operation sensors as follows:
 - 1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg.
 - 2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
 - 3. Status Inputs for Direct Drive Electric Motors: Current-sensing relay with current transformers, adjustable and sized for one hundred seventy-five percent (175%) of rated motor current.

4. Status Inputs for Belt Drive Electric Motors: Current sensing transmitter with linear 4-20mA output.
- I. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 0 to 10 V dc, feedback signal.
- J. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vapor proof type.
- K. Air Differential Pressure Switches: Diaphragm type air differential pressure switches with die cast aluminum housing, adjustable setpoint, minimum 5-amp switch rating at 120VAC, SPDT switches, and the switch pressure range shall be suited for the application. Provide Dwyer or equal. These switches shall be utilized for filter status.
- L. Leak Detectors: Provide spot leak detectors that can be secured to the floor or secured to a drain pan. The detection shall use a microchip controlled energized probes. The detector shall operate on 24V or less. Provide a way to adjust the height of the leak probes. The SPDT contacts shall be inside a watertight enclosure.

2.11 ELECTRO-MECHANICAL THERMOSTATS

- A. Fire-Protection Thermostats: UL listed with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, with the following:
 1. Reset: Automatic with control circuit arranged to require manual reset at central control panel, with pilot light and reset switch on panel labeled to indicate operation.
- B. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point. Setpoint shall be adjustable.
 1. Bulb Length: Minimum 20 feet.
 2. Quantity: One (1) thermostat for every 20 sq. ft. of coil surface.
- C. Electric Space Thermostats: Provide a charged element type stat with snap acting SPDT switch. The switch shall be rated for 16A or 1HP at 120V.
- D. Aquastat: Provide a charged element type stat with snap acting SPDT switch. The switch shall be rated for 16A or 1HP at 120V.

2.12 AUTOMATIC CONTROL VALVES

- A. General:
 1. All automatic control valves shall be fully proportioning, unless specified otherwise. The valves shall be quiet in operation and fail-safe in either normally open or normally closed position in the event of control air failure. All valves shall be capable of operating at varying rates of speed to correspond to the exact dictates of the controllers and variable load requirements. The valves shall be capable of operating in sequence with other valves and/or dampers when required by the sequence of operation. All control valves shall be sized by the control vendor and shall be guaranteed to accommodate the flow rates as scheduled. All control valves shall be suitable for the pressure conditions and shall close against the differential pressures involved. Body pressure rating and connection type construction shall conform to fitting and valve schedules. Control valve

- operators shall be sized to close against a differential pressure equal to the design pump heads plus ten percent (10%).
2. Cold water, hot water and steam valves, throttling type, and bypass valves shall have equal percentage flow characteristics.
3. Unless otherwise specified, control valves 2 inches and smaller shall have cast iron or bronze bodies with screwed NPT connections.
4. Valves between 2½- and 4-inch shall have cast iron bodies with flanged connections.
5. All automatic control valves installed exposed to the elements shall be provided with electric actuators with operating characteristics and accessories as described in herein. Coordinate with electrical contractor for power availability and point of connection.
6. All automatic control valves controlled by the BAS shall be furnished by the controls contractor unless noted otherwise in these documents.
7. All automatic control valves shall be installed by the mechanical trade.
8. The controls contractor shall provide wiring as follows:
 - a. All line voltage power for electric valve actuators shall be wired by the controls contractor from the nearest available power panel. Coordinate with electrical trade.
 - b. All wiring between the central control system (ATC/BMS) and the valve actuator shall be wired by the controls contractor.
 - c. All wiring between the valve actuator and their associated thermostats, pressure switches, control devices, etc. shall be wired by the controls contractor.
 - d. All wiring shall comply with code requirements. Segregate high and low voltage wiring and circuits and segregate the FAS and controls (BMS) terminals.

B. Characterized Ball Valves:

1. All control valves shall be sized by the control vendor. All control valve bodies shall be suitable for the static and dynamic pressures of the system. Control valve operators shall be sized to close against a differential pressure equal to the design pump head plus ten percent (10%).
2. Body pressure rating and connection type construction shall conform to fitting and valve schedules.
 - a. Design body pressure shall be determined by adding the static pressure due to the height of the system plus the compression tank charge plus the maximum head of the system pump at cut off. Provide ten percent (10%) design factor.
3. The valve seat differential pressure rating shall exceed the pump dynamic head design pressure.
4. All automatic control valves controlled by the BAS shall be furnished by the controls contractor unless otherwise noted in these documents.
5. All automatic control valves shall be installed by the mechanical trade.
6. The controls contractor shall provide wiring as follows:
 - a. All line voltage power for electric valve actuators shall be wired by the controls contractor from the nearest available power panel. Coordinate with electrical trade.
 - b. All low voltage wiring between the controller and the valve actuator shall be wired by the controls contractor.
 - c. All wiring between safeties and the valve actuator shall be wired by the controls contractor.
 - d. All wiring shall comply with code requirements. Segregate high and low voltage wiring and circuits and segregate the Fire Alarm (FACS) and BAS controls wiring.

- C. Manufacturer: Siemens **599 Series** valves bodies, SSD, SAX, SQV Actuators, Series **230, 231, 232, 233, 238, 239, 371, and 373** assemblies.

D. Threaded Valves, Line Size ½ to 2-Inch:

1. Controlled Media Specific Items:

- a. The control valve shall be suitable for chilled water to a minimum of 35°F and hot water to a maximum temperature of 250°F. 3-way 1½- and 2-inch valves shall be suitable for chilled water to a minimum of 35°F and hot water to a maximum temperature of 230°F.
- b. The control valve shall be suitable for up to fifty percent (50%) ethylene or propylene glycol solutions, chilled glycol/water solutions to a minimum of 35°F and hot glycol/water solutions to a maximum temperature of 250°F. 3-way 1½- and 2-inch valves shall be suitable for up to fifty percent (50%) ethylene or propylene glycol solutions, chilled glycol/water solutions to a minimum of 35°F and hot glycol/water solutions to a maximum temperature of 230°F.

2. General Construction Materials/Applicable Standards:

- a. Control valve bodies shall be constructed of forged brass according to ASTM B 283 (C37700, CuZn39Pb2 or equivalent), and shall meet requirements of ANSI 250 and 600WOG pressure classes.
- b. Inlets and outlets shall be clearly marked on the valve bodies.
- c. Valve ball shall consist of nickel-plated brass, chrome-plated brass, or stainless-steel.
- d. End connections shall be NPT internally threaded according to ANSI B1.20.1.
- e. The control valve flow rate (Cv) shall meet the requirements of ANSI/ISA S75.02.
- f. The control valve shall have an equal percentage flow characteristic, according to ANSI/ISA S75.11. A single glass filled PTFE V port insert shall provide both the ball seal and shall establish the flow coefficient of the valve. The V port insert shall be retained by the valve body itself, not requiring additional retaining components. Flow coefficient adapters requiring a retainer clip, or installed after final assembly of the valve or as inserts in the ball shall not be allowed.
- g. 2-way valves and the A-AB path on 3-way valves shall meet the requirements of ANSI Class IV (0.01% of rated Cv) seat leakage, or better, according to ANSI/FCI 70.2, at the specified close-off pressure. Bypass path (B-AB) on 3-way valves shall meet the requirements of ANSI Class III (0.1% of rated Cv) seat leakage, or better, according to ANSI/FCI 70.2.
- h. Chilled and Hot water valve shall have a blow-out proof stem with two (2) EPDM (peroxide cured) O-rings. External stem retainers will not be allowed.
- i. Valve stem shall be made of brass or stainless-steel.
- j. Valve shall have the ability to be manually operated in the event of a power failure.

E. Actuators – Electric

- 1. The valves shall be provided with an actuator by the same manufacturer, factory installed.
- 2. All actuators shall have visual position indication.
- 3. No external programming device shall be required.
- 4. Actuator shall be electric motor driving, microprocessor signal controlled.
- 5. Modulating valves shall be positive positioning, responding to a 0-10VDC, 2-10VDC, or 4-20mA signal. Floating modulating signals are acceptable for modulation on terminal units and radiation units. There shall be a visual valve position indicator.
- 6. Power: All actuators shall be 24VAC power and less than 100VA draw. Power shall be via Class 2 wiring. Actuators requiring more than 100VA shall have a dedicated conduit for power wiring, not mixed with the signal wiring.

7. Fail Safe: Valves actuators shall position the valve in a fail-safe position when the power supply is disrupted or the signal goes to 0. Fail-safe according to the following guidelines unless otherwise stated in the sequence of operations
 - a. Power fail safe shall be via spring loaded mechanical means.
 - b. Any AHU hot water exposed to ventilation air shall fail open.
 - c. AHU chilled water coils exposed to ventilation air in possible freezing conditions shall be fail open.
 - d. AHU chilled water coils that are drained in winter months or are in climate zones without freezing conditions shall be fail-in-place.
 - e. Terminal unit valves shall fail-in-place.
 8. Fail-safe valves on primary equipment such as chilled water systems, hot water systems and condenser water systems shall have a means to manually open the valve when power is not available, such as a hand wheel or a geared crank with a clutch.
 9. The actuator shall be designed with a current limiting motor protection. A release button (clutch) or handle on the actuator shall be provided to allow for manual override (except when actuator is spring return type).
 10. Actuator shall provide minimum torque required for proper valve close-off. The close-off differential pressure rating of the valve shall exceed the highest possible head pressure available at the pump plus ten percent (10%), and still be rated for a Class IV leakage.
 11. The actuator shall have the capability of adding auxiliary switches or feedback potentiometer if specified.
 12. All automatic control valves installed in locations exposed to the elements shall be provided with weather resistant housings and heaters for climates that reach below freezing.
 13. Actuators shall be UL and CSA listed.
- F. Hot Water/Condenser Water/Control Valves
1. Single-seated.
 2. Fully proportioning with modulating plug or V-port inner valves.
 3. Body pressure rating and connection type construction shall conform to fitting and valve schedules. The ANSI rating of the valve shall match the ANSI rating of the piping in which the valve is installed. Minimum ANSI rating shall be ANSI 125.
 4. Stainless-steel stems and trim.
 5. Spring loaded Teflon packing
 6. Quiet in operation.
 7. Fail-safe in either normally open or normally closed position in the event of power failure.
 8. Capable of operating in sequence with other valves and/or dampers when required by the sequence of operation.
 9. Capable of operating at varying rates of speed to correspond to the exact dictates of the controller and variable load requirements.
- G. Differential Pressure Control Valves: Provide for all water systems where modulating water flow conditions are required to prevent excessive pump pressure build-up. Provide a valve for each closed loop water system. Valve to be globe type. Provide valves 2-inch and smaller with screwed end bodies and provide valves 2½-inch and larger with flanged ends.
- H. Steam Valves:
1. Steam control valves shall be of linear flow characteristics for modulating service.
 2. Sizing Criteria:
 - a. 15 psig or less; pressure drop eighty percent (80%) of inlet psig.
 - b. 16 to 50 psig; pressure drop fifty percent (50%) of inlet psig.

- c. Over 50 psig; pressure drop as scheduled on Drawings.
- d. Steam valves shall fail normally open or closed, as scheduled on plans, or as follows:
 - 1) Heating Coils in Air Handlers: Normally open.
 - 2) Steam to Hot Water Heat Exchanger: Normally closed.
 - 3) Other Applications: As required by sequences of operation.

2.13 ELECTRONIC ACTUATOR SPECIFICATION

A. Electronic Valve Actuators:

- 1. Actuator shall be fully modulating, floating (tri-state), two-position, and/or spring return as indicated in the control sequences. Specified fail-safe actuators shall require mechanical spring return.
- 2. Modulating valves shall be positive positioning, responding to a 2-10VDC or 4-20mA signal. There shall be a visual valve position indicator.
- 3. The actuator shall have the capability of adding auxiliary switches or feedback potentiometer if specified.
- 4. Actuator shall provide minimum torque required for proper valve close-off. The actuator shall be designed with a current limiting motor protection. A release button (clutch) or handle on the actuator shall be provided to allow for manual override (except when actuator is spring return type).
- 5. Actuators shall be UL listed.

B. Electronic Damper Actuators:

- 1. Actuator shall be direct coupled (over the shaft), enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator-to-shaft clamp shall use a "V" bolt and "V" shaped, toothed cradle to attach to the damper shaft for maximum holding strength. Single bolt or set screw type fasteners are not acceptable.
- 2. Actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. End switches to deactivate the actuator at the end of rotation or magnetic clutch are not acceptable.
- 3. For power-failure/safety applications, a mechanical, spring return mechanism shall be used.
- 4. Actuators with spring return mechanisms shall be capable of either clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
- 5. Proportional actuators shall accept a 2-10VDC, 4-20mA signal, or be of the 2-point floating type and provide a 2-10VDC actuator position feedback signal.
- 6. All actuators shall have an external manual gear release (clutch) or manual crank to aid in installation and for allowing manual positioning when the actuator is not powered.
- 7. All actuators shall have an external direction of rotation switch to aid in installation and to allow proper control response.
- 8. Actuators shall be provided with a factory-mounted 3-foot electrical cable and conduit fitting to provide easy hook-up to an electrical junction box.
- 9. Actuators shall be listed under Underwriters Laboratories Standard 873 and Canadian Standards Association. They must be manufactured under ISO 9001.

PART 3 - PRODUCTS

3.1 EXAMINATION

- A. The project Drawings shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.
- B. The Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.
- C. The Contractor shall examine the Drawings and Specifications for other parts of the work. If headroom or space conditions appear inadequate, or if any discrepancies occur between the Drawings and the Contractor's work and the Drawings and the work of others, the Contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the Contractor's work with the work of others.

3.2 INSTALLATION

- A. Provide all relays, switches, sources of emergency and UPS battery back-up electricity, and all other auxiliaries, accessories, and connections necessary to make a complete operable system in accordance with the sequences specified. All field wiring shall be by this contractor.
- B. Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.
- C. Mount surface-mounted control devices on brackets to clear the final finished surface on insulation.
- D. Install equipment level and plumb.
- E. Install control valves horizontally with the power unit up.
- F. Unless otherwise noted, install wall mounted thermostats and humidistat 60 inches above the floor measured to the center line of the instrument, or as otherwise directed by the Architect.
- G. Install averaging elements in ducts and plenums in horizontal crossing or zigzag pattern.
- H. Install outdoor sensors in perforated tube and sunshield.
- I. Install damper motors on outside of duct in protected areas, not in locations exposed to outdoor temperatures.
- J. Install labels and nameplates on each control panel listing the name of the panel referenced in the graphics and a list of equipment numbers served by that panel.
- K. Furnish hydronic instrument wells, valves, and other accessories to the mechanical contractor for installation.
- L. Furnish automatic dampers to mechanical contractor for installation.

3.3 GRAPHIC DISPLAY GENERATION

- A. All software shall be capable of providing color graphics. All software shall include a graphical viewing and control environment and definition and construction of dynamic color graphic displays.
- B. Provide a main default screen showing the basic layout of the building. Each color graphic screen shall have transfer links to allow the building operator to transfer between system associated screens (both forward and backward), as well as a transfer link back to the main default screen.
- C. Basic CAD floor plans with layers for walls, windows, low pressure ductwork only, supply diffusers, and room numbers shall be provided for all CV, VAV, and FPVAV terminal units. Floor plans shall show the location of each space temperature sensor with a dashed line to the associated terminal unit. Display in real time the difference between the space temperature and the current setpoint.
 - 1. Display the cooling percentage (%), heating percentage (%) (if applicable), and current CFM of each terminal unit.
 - 2. Provide a transfer link for each terminal unit to allow the operator to access the flow graphic for each individual terminal unit. Use a different color to shade the background area for each part of a floor plan graphic served by a different air handling unit.
- D. All control set points shall be easily adjustable from the system's color graphic screen by operators with the proper access level. Each controlled point on the BAS operator workstation color graphic screens shall have the set point indicated along with the actual controlled variable reading (preferred set point on top and actual reading on bottom). All points shall indicate the associated engineering unit. All analog outputs points shall indicate engineering units such as "percent (%) -open" or "percent (%) -closed" as required by the application. All normally-closed or normally-open points shall indicate the normal position (such as "N.C." or "N.O." next to the controlled device).
- E. Provide system color graphics for each HVAC system and for each electrical, plumbing and/or piping system that is monitored and/or controlled by the BMS. Provide scaled floor plans indicating equipment location, service, and system data as required.
- F. Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including but not limited to air handling units, chilled water systems, and hot water systems to optimize system performance analysis and speed alarm recognition.
- G. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.
- H. Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
- I. The windowing environment of the operator interface shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
 - 1. Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.), and electrical symbols.

2. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility.
 - J. Provide an automatically updated, dynamic display of the site-specific BMS architecture indicating the status of primary and secondary controllers.
 - K. Provide a separate dynamic display page of each HVAC (AHU, AC, chiller, cooling tower, fuel oil, etc.), electrical, and/or plumbing system connected to the BMS.
 - L. Provide a separate dynamic display page of each piece of terminal equipment (VAV box, fan coil unit, etc.) connected to the BMS.
 - M. Provide additional dynamic, graphic display pages as required by the operating staff to further assist in daily system operations.
 - N. Graphics shall incorporate all system integration points communicated via hardware or software gateways and/or interfaces. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.
 - O. Each graphic shall have a "BACK" button and a "HOME" or "MAIN" button located in the same location on all graphics.
 - P. The operator shall be able to clearly distinguish the difference between the following types of points on a graphic either by color, shape, icon, or text label:
 1. Real-time sensor reading.
 2. Setpoint.
 3. Manually set vs. program set setpoint.
 4. Real-time output reading.
 5. Manually overridden or commanded output vs program set output.
 6. Status feedback from a piece of equipment vs the output command.
 - Q. Make links to additional information associated with the system on the graphic appear, such as:
 1. Controls as-built schematics and wiring diagrams.
 2. As-built Sequence of Operation.
 3. Mechanical drawings.
 4. Electrical drawings.
 - R. Integration graphics shall be representative of personnel standing in front of equipment. The graphics for equipment specified in the Building Systems Integration paragraph shall be representative of the manufacturers' local display panel and each shall be completely operable from the computer workstation.
- 3.4 ELECTRICAL WIRING SCOPE
- A. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.

1. Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.
- B. This contractor shall not be responsible for power to control panels and control devices that are furnished by others, unless it is part of the control interlock wiring.
- C. Refer to coordination section for what devices this contractor is responsible to mount and which are turned over to others to mount.
- D. This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.
- E. Interlock wiring shall be run in separate conduits from BAS associated wiring.
- F. Provide network wiring for equipment that is called to be integrated to the BAS.

3.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. All low voltage control wiring shall be class 2. Control wiring that is not class 2 shall be run in separate conduits from class 2 wiring.
- B. Floor level network wiring between terminal units can be combined with thermostat and other low voltage wiring in the same conduit. All other network wiring shall be in dedicated conduits.
- C. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems".
- D. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables".
- E. Installation shall meet the following requirements:
 1. Conceal cable and conduit, except in mechanical rooms and areas where other conduit and piping are exposed.
 2. Install exposed cable in raceway or conduit.
 3. Install concealed cable using plenum rated cable.
 4. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 7. All wiring in lab areas shall be in conduit.
 8. All unsupported risers shall be rigid steel conduit. Supported risers shall be EMT.
- F. Rigid conduit shall be steel, hot dip galvanized, threaded with couplings, 3/4-inch minimum size, manufactured in accordance with ANSI C-80-1. Electrical metallic tubing (EMT) with compression fittings or intermediate metallic conduit (IMC) may be used as conduit or raceway where permitted by the NEC.
- G. Concealed control conduit and wiring shall be provided in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90-degree angles.
- H. Install conduit adjacent to machine to allow service and maintenance.

- I. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- J. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- K. Ground equipment.

3.6 COMMUNICATION WIRING

- A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- B. Do not install communication wiring in raceway and enclosures containing Class 1 wiring.
- C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- D. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
- E. Cable Bundling:
 - 1. RS485 cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.
 - 2. RS485 cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.
 - 3. RS485 cabling run between floors shall be in a communication-only conduit.
 - 4. RS485 conduit run long distances between utility rooms or between buildings shall be in a communication-only conduit.
 - 5. Ethernet cabling shall be in a communication-only conduit.
 - 6. Ethernet and RS485 can be run together.
 - 7. Fiber optics can be run with Ethernet and RS485 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.
- F. RS485 Cabling:
 - 1. RS485 cabling shall be used for BACnet MS/TP networks.
 - 2. RS485 shall use low capacitance, 20-24 gauge, twisted shielded pair.
 - 3. The shields shall be tied together at each device.
 - 4. The shield shall be grounded at one (1) end only and capped at the other end.
 - 5. Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.
- G. Ethernet Cabling:
 - 1. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
 - 2. CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
 - 3. Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.
 - 4. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.
- H. Fiber-Optic Cabling:

1. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
 2. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.
 3. All terminations shall be made into a patch panel, designed for such use. Free air terminations with patch panels are prohibited.
- I. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.
 - J. All runs of communication wiring shall be unspliced length when that length is commercially available.
 - K. All communication wiring shall be labeled to indicate origination and destination data.
 - L. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- 3.7 IDENTIFICATION
- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.
 1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows: C A U T I O N This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.
 - B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
 1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows: C A U T I O N This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.
 - C. Control Equipment and Device Labeling:
 1. Labels and tags shall match the unique identifiers shown on the as-built drawings.
 2. All enclosures shall be labeled to match the as-built drawing by either control panel name or the names of the DDC controllers inside.
 3. All sensors and actuators not in occupied areas shall be tagged.
 4. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.
 5. Duct static pressure taps shall be tagged at the location of the pressure tap.
 6. Each device inside enclosures shall be tagged.
 7. Terminal equipment need only have a tag for the unique terminal number, not for each device. Match the unique number on:
 - a. First, the design drawings, or
 - b. Second, the control as-builts, or
 - c. Third, the DDC addressing scheme.

- 8. Tags on the terminal units shall be displayed on the Operator Workstation Graphics.
- D. Tags shall be mechanically printed on permanent adhesive backed labeling strips, 12-point height minimum.
- E. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- F. Identification of Wires:
 - 1. Tag each wire with a common identifier on each end of the wire, such as in the control panel and at the device termination.
 - 2. Tag each network wire with a common identifier on each end.
 - 3. Tag each 120V power source with the panel and breaker number it is fed by.
- G. Identification of Conduits:
 - 1. Identify the low voltage conduit runs as BAS conduit, power feeds not included.
 - 2. Identify each electric box, junction box, utility box, and wiring tray with a blue paint mark or blue permanent adhesive sticker.
 - 3. For conduit runs that run more than 8 feet between junction boxes in one (1) room, place a blue identifier at least every 8 feet.
 - 4. Place a blue identifier on each side of where a conduit passed through a wall or other inaccessible path.
 - 5. Identify all BAS communication conduits the same as above.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
 - 3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
- B. Engage a factory-authorized service representative to perform startup service.
- C. Replace damaged or malfunctioning controls and equipment.
 - 1. Start, test, and adjust control systems.
 - 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 - 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.9 SYSTEM CHECKOUT AND STARTUP

- A. Inspect each termination in the MER control panels and devices to make sure all wires are connected according to the wiring diagrams and all terminations are tight.

- B. After the controls devices and panels are installed and power is available to the controls, perform a static checkout of all the points, including the following:
 - 1. Inspect the setup and reading on each temperature sensor against a thermometer to verify its accuracy.
 - 2. Inspect the setup and reading on each humidity sensor against a hygrometer to verify its accuracy.
 - 3. Inspect the reading on each CO₂ sensor using a calibration kit to verify the sensor range accuracy matches the DDC setup.
 - 4. Inspect the reading of each status switch to verify the DDC reads the open and close correctly.
 - 5. Command each relay to open and close to verify its operation.
 - 6. Command each 2-position damper actuator to open and close to verify operation.
 - 7. Command each 2-position valve to open and close to verify operation.
 - 8. Ramp each modulating actuator to zero percent (0%), twenty-five percent (25%), fifty percent (50%), seventy-five percent (75%), and one hundred percent (100%) to verify its operation.
 - 9. Ramp each modulating output signal, such as a VFD speed, to verify its operation.
 - 10. Test each safety device with a real-life simulation, for instance check low temperature detectors with ice water, water detectors with water, etc.
- C. Document that each point was verified and operating correctly. Correct each failed point before proceeding to the dynamic startup.
- D. Verify that each DDC controller communicates on its respective network correctly.
- E. After all the points are verified, and power is available to the mechanical system, coordinate a startup of each system with the mechanical contractor. Include the following tests:
 - 1. Start systems from DDC.
 - 2. Verify that each setpoint can be met by the system.
 - 3. Change setpoints and verify system response.
 - 4. Change sensor readings to verify system response.
 - 5. Test safety shutdowns.
 - 6. Verify time delays.
 - 7. Verify mode changes.
 - 8. Adjust filter switches and current switches for proper reactions.
 - 9. Adjust proportional bands and integration times to stabilize control loops.
- F. Perform all program changes and debugging of the system for a fully operational system.
- G. Verify that all graphics at the operator workstations correspond to the systems as installed. Verify that the points on the screens appear and react properly. Verify that all adjustable setpoints and manual commands operate from the operator workstations.
- H. After the sequence of operation is verified, setup the trends that are listed in the sequence of operations for logging and archiving for the commissioning procedure.

3.10 SYSTEM COMMISSIONING, DEMONSTRATION, AND TURNOVER

- A. The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, inter-locks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Engineer, the BAS contractor shall completely test the BAS using the approved test procedure.

- B. After the BAS contractor has completed the tests and certified the BAS is one hundred percent (100%) complete, the Engineer shall be requested, in writing, to approve the satisfactory operation of the system, sub-systems and accessories. The BAS contractor shall submit Maintenance and Operating manuals at this time for approval. An acceptance test in the presence of the Engineer and Owner's representative shall be performed. The Owner will then shake down the system for a fixed period of time (thirty (30) days).
- C. The BAS contractor shall fix punch list items within thirty (30) days of acceptance.
- D. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

3.11 TRAINING

- A. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the Owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware, and accessories.
- B. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give 8 hours of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:
 - 1. Explanation of drawings and operator's maintenance manuals.
 - 2. Walk-through of the job to locate all control components.
 - 3. Operator workstation and peripherals.
 - 4. DDC Controller and ASC operation/sequence.
 - 5. Operator control functions including scheduling, alarming, and trending.
 - 6. Explanation of adjustment, calibration and replacement procedures.
- C. Additional 8-hours of training shall be given after the 30-day shakedown period.
- D. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer's standard pricing such as transportation, meals, etc.

END OF SECTION 230923

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED SECTIONS

- 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 control sequences for HVAC systems, subsystems, and equipment.
- B. Related Sections:
 - 1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

- A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).
- B. ATC: Automatic Temperature Control Contractor conducting work by and under this section.
- C. Binary Output: On/off output signal or contact closure.
- D. BMS: Building Management System.
- E. BMCS: Building Management Control System.
- F. BMS and FMS and BMCS are equivalent regarding definition and scope.
- G. CO₂: Carbon Dioxide.
- H. DDC: Direct digital control.
- I. Digital Output: Data output that must be interpreted digitally.
- J. DOAS: Dedicated Outside Air System.
- K. ERV: Energy Recovery Ventilator.
- L. MAU: Makeup Air Handling Unit.
- M. RTU: Rooftop Unit.
- N. VAV: Variable air volume.
- O. VFD: Variable Frequency Drive.
- P. VRF: Variable Refrigerant Flow.

1.4 GENERAL CONTROL SEQUENCES

- A. Controls Contactor shall have a meeting with the Architect, Engineer, and Owner prior to programming to discuss capabilities, schedules, and sequences.
- B. Contractor shall provide all required control devices, meters, hardware, and software to achieve the specified sequences of operation as outlined in these specifications and as detailed on Drawings whether indicated and/or implied. Refer to Drawings for general I/O points. All points may not be listed and are indicated for general description.
- C. BMS shall monitor and report all control function alarm points.
- D. System shall have capacity to store trend data for no less than one (1) year.
- E. The BMS shall monitor all fans status via a current sensor. If anytime the fan is enabled and current is not sensed, an alarm shall be initiated at the BMS central computer and at the local panel.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE

- A. BMS contractor to work with Owner on equipment scheduling.

3.2 RTU

- A. BMS contractor shall integrate via BACnet to the RTU Factory Controller. BMS contractor shall provide low voltage control wiring for RTU manufacturer field mounted devices.
- B. Building Automation System Interface: The Building Automation System (BAS) shall send the controller Occupied Bypass, Morning Warm-up/Pre-Cool, Occupied/Unoccupied and Heat/Cool modes. The BAS shall also send the discharge air temperature setpoint and the duct static pressure setpoint. If a BAS is not present, or communication is lost with the BAS the controller shall operate using default modes and setpoints.
- C. Occupied: During occupied periods, the supply fan shall run continuously and the mixed air dampers shall open to maintain minimum ventilation requirements. The unit controller shall control the supply fan speed to maintain the current supply duct static pressure setpoint (adj.). Upon a call for DX heating or cooling, the unit controller shall enable the first fixed speed compressor. If the fixed speed compressor cannot satisfy the load conditions, the unit controller shall start the next fixed speed compressor in sequence to add to the total unit heating or cooling load percentage. This process shall repeat until all of the fixed speed compressors have been started or until the active discharge air temperature setpoint is satisfied. During the DX heating cycle, the electric heat shall be enabled and used to help maintain the active discharge air temperature setpoint. If economizing is enabled, the outdoor air or mixed air dampers shall modulate to maintain the discharge air temperature setpoint and the relief air damper shall track the mixed air dampers.
- D. Unoccupied: When the space temperature is below the unoccupied heating setpoint of 60 deg. F (adj.), the supply fan shall be commanded on, the outside air damper shall remain closed, and the electric heat shall be enabled. When the space temperature rises above the unoccupied

heating setpoint of 60.0 deg. F (adj.) plus the unoccupied differential of 4.0 deg. F (adj.), the supply fan shall stop and the electric heat shall be disabled.

- E. Optimal Start: The BAS shall monitor the scheduled occupied time, occupied space setpoints, and space temperature to calculate when the optimal start occurs.
- F. Optimal Stop: The BAS shall monitor the scheduled unoccupied time, occupied setpoints, and space temperature to calculate when the optimal stop occurs. When the optimal stop mode is active the unit controller shall maintain the space temperature to the space temperature offset setpoint. Outside air damper shall remain enabled to provide minimum ventilation.
- G. Morning Warm-Up Mode: During optimal start, if the average space temperature is below the occupied heating setpoint a morning warm-up mode shall be activated. When morning warm-up is initiated, the unit shall enable the heating and fan(s). The outside air damper shall remain closed. When the space temperature reaches the occupied heating setpoint (adj.), the unit shall transition to the Occupied Mode.
- H. Pre-Cool Mode: During optimal start, if the average space temperature is above the occupied cooling setpoint, pre-cool mode shall be activated. When pre-cool is initiated, the unit shall enable the fan and cooling or economizer. The outside air damper shall remain closed, unless economizing. When the space temperature reaches occupied cooling setpoint (adj.), the unit shall transition to the Occupied Mode.
- I. Occupied Bypass: The BAS shall monitor the status of the ON and CANCEL buttons of the space temperature sensors. When an occupied bypass request is received from a space sensor, the unit shall transition from its current occupancy mode to occupied bypass mode and the unit shall maintain the space temperature to the occupied setpoints (adj.).
- J. Heat/Cool Mode:
 - 1. Cooling: The unit controller shall use the discharge air temperature sensor and discharge air temperature cooling setpoint to determine when to initiate requests for cooling. Discharge air setpoint shall be maintained by controlling the cooling as required.
 - 2. Heating: The unit controller shall use the discharge air temperature sensor and discharge air temperature heating setpoint to determine when to initiate requests for heating. Discharge air setpoint shall be maintained by controlling the heating as required. During Unoccupied Heating or Morning Warm-Up Mode, the unit heat request shall be communicated to the system VAVs prior to commencing heating operation to allow VAV units to open. The variable frequency drive shall be commanded to one hundred percent (100%) and the heat shall be staged on and off to satisfy the zone temperature setpoint.
- K. Supplemental Heat for Heat Pump Configuration: The supplemental electric heat shall be cycled on as the last stage of heating. Supplemental electric heat shall operate concurrently with the DX heating, as needed, to maintain space temperature.
- L. Discharge Air Temperature Reset Control: The discharge air temperature setpoint shall be reset to the optimal setpoint communicated by the BAS. The BAS shall reset the discharge air temperature setpoint based on the current outside air temperature, but shall override this reset function and return the discharge air temperature setpoint to 55.0 deg. F (adj.) if more than two (2) (adj.) zones begin to overheat. Also, the BAS shall override this reset function whenever outdoor dew point is higher than 60.0 deg. F (adj.) or indoor humidity is higher than sixty percent (60%) RH (adj.). If the discharge air temperature drops below the minimum limit, a low temperature alarm shall annunciate and the unit shall shut down. If the discharge air temperature rises above the maximum limit, a high temperature alarm shall annunciate.

M. Dehumidification:

1. The unit shall be in dehumidification mode if the return humidity is above the dehumidification setpoint. In the Dehumidification Mode, the supply air fan shall be enabled, the outside air damper shall be commanded to minimum position, and the unit controller shall energize mechanical cooling and the hot gas reheat coil shall modulate.
2. During Dehumidification Mode, the outside air temperature shall be monitored. If this temperature rises above the reheat capacity limit setpoint or falls below the reheat capacity limit setpoint – 3.0 deg. F (adj.), the unit shall stage down or stage up the compressors respectively to meet full or part load capacity requirements based on ambient temperature. Factory installed hot gas reheat shall allow application of dehumidification. Dehumidification shall be allowed only when the outside air temperature is above 40.0 deg. F and below 100.0 deg. F. The economizer outside air damper shall drive to minimum position during dehumidification.
3. On a call for dehumidification, the hot gas reheat valve in circuit 1 shall energize and the compressor(s) shall enable. When the humidity control setpoint is satisfied, the valve shall be de-energized and the compressor(s) in circuit 1 shall be disabled. If there is a call for 1st stage cooling while in the dehumidification mode, no action shall take place. If there is a call for 2nd stage cooling, the hot gas reheat valve shall be de-energized, and the unit shall revert to the cooling mode. If 2nd stage cooling is satisfied and there is still a call for dehumidification, the hot gas reheat valve shall once again be energized.

N. Economizer:

1. Enable (Comparative Enthalpy): Outside air (OA) enthalpy shall be compared with Return air (RA) enthalpy point. The economizer shall enable when OA enthalpy is less than RA enthalpy - 2.0 BTU/LB. The economizer shall disable when OA enthalpy is greater than RA enthalpy.
2. Operation: The supply air sensor shall measure the dry bulb temperature of the air leaving the evaporator coil while economizing. When economizing is enabled and the unit is operating in the cooling mode, the economizer damper shall be modulated between its minimum position and one hundred percent (100%) to maintain the discharge air temperature setpoint. The economizer damper shall modulate toward minimum position in the event the discharge air temperature falls below the discharge low limit temperature setpoint. Compressors shall be delayed from operating until the economizer has opened to one hundred percent (100%).

O. Supply Fan: The supply fan shall be enabled while in the Occupied Mode and cycled on during the Unoccupied Mode.

P. Supply Duct Static Pressure Control: During the Occupied Mode, the unit controller shall modulate the output to the variable frequency drive as required to maintain the supply duct static pressure setpoint of 1.5 inches of W.C. (adj.). If the supply duct static pressure falls below 1.3 inches of W.C. (adj.), the unit controller shall increase the output to the variable frequency drive to maintain setpoint. If the supply duct static pressure rises above 1.7 inches of W.C. (adj.), the unit controller shall decrease the output to the variable frequency drive to maintain setpoint. Upon a call for heating or cooling in the Unoccupied Mode, the unit controller shall modulate the speed of the variable frequency drive to one hundred percent (100%).

Q. Static Pressure High Limit: If for any reason the supply air pressure exceeds the supply air pressure high limit, the supply fan shall shut down. The unit shall be allowed to restart three (3) times after a 15-minute off period. If the over-pressurization condition occurs on the fourth restart, the unit shall shut down and a manual reset diagnostic is displayed at the remote panel and/or the BAS system. If for any reason the supply air pressure exceeds the fixed supply air pressure limit of 3.5 inches of W.C., the supply fan shall shut down. The unit shall be allowed to restart

three (3) times. If the over pressurization condition occurs on the fourth restart, the unit shall shut down and a manual reset diagnostic is displayed at the remote panel and/or the BAS system.

- R. Filter Timer: The fan-run time (hrs) shall be compared to the filter maintenance timer setpoint. Once the setpoint is reached a filter timer alarm diagnostic shall annunciate at the BAS. When the diagnostic is cleared, the filter-maintenance timer is reset to zero, and the timer begins accumulating fan-run time again.
- S. Condensate Overflow Shutdown: The unit shall shut down in response to a signal from the condensate overflow sensor. The sensor shall be interlocked to the unit cooling controller for immediate shutdown of cooling.
- T. Refrigerant Mitigation Mode:
 - 1. The unit controller shall monitor the leak detection system every 5 seconds, when a leak is detected, mitigation shall be activated.
 - 2. In Occupied Mode, the supply fan shall remain operational, and the compressor(s), electric heating, fuel-fired heating, electrostatic devices, and any other ignition device starters shall be disabled, and activate mechanical ventilation (if it's required by Section 7.6.4 of the ASRAE standard) for the duration of the mitigation process plus an additional 5 minutes.
 - 3. In Unoccupied Mode, the supply fan shall remain operational, and the compressor(s), electric heating, fuel-fired heating, electrostatic devices, and any other ignition device starters shall be disabled, and activate mechanical ventilation (if it's required by Section 7.6.4 of the ASRAE standard) for the duration of the mitigation process plus an additional 5 minutes.
- U. BACnet Monitoring Points: At a minimum, the BMS shall monitor the following I/O points through the unit's BACnet interface:
 - 1. Supply Fan Status and Speed
 - 2. Exhaust Fan Status and Speed
 - 3. Compressor/Cooling Capacity
 - 4. Heating Status and Capacity
 - 5. Dehumidification Status and Hot-Gas Reheat Capacity
 - 6. Filter Status
 - 7. Supply Duct Static Pressure and Setpoint
 - 8. Supply Air, Return Air and Outside Air Temperatures
 - 9. Outside and Return Air Enthalpy
 - 10. Return Air Relative Humidity
 - 11. Leaving Coil/Entering Fan Temperature
- V. Alarms: The following items will generate alarms within the BMS.
 - 1. Supply Air Temperature Out of Range
 - 2. Smoke Shutdown Alarm
 - 3. Supply Fan Status Failure (through BACnet)
 - 4. Exhaust Fan Status Failure (through BACnet)
 - 5. Clogged Filter Status (through BACnet)
- W. Graphics: The following items will be displayed on the BMS graphics:
 - 1. Complete System Graphic including temperature, humidity, pressure, airflow, setpoints, commands and status.
 - 2. Outside Temperature and Humidity
 - 3. Alarm Conditions

4. Occupied/Unoccupied Mode

3.3 VAV BOXES w/HOT WATER REHEAT

A. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule in the following modes:

1. Occupied Mode: The unit shall maintain:

- a. 75°F (adj.) cooling setpoint
- b. 70°F (adj.) heating setpoint.

2. Unoccupied Mode (night setback): The unit shall maintain:

- a. 85°F (adj.) cooling setpoint.
- b. 55°F (adj.) heating setpoint.

B. Alarms shall be provided as follows:

- 1. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
- 2. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

C. Minimum Ventilation on Carbon Dioxide (CO₂) Concentration: When in the Occupied Mode, the controller shall measure the zone CO₂ concentration and modulate the zone damper open on rising CO₂ concentrations, overriding normal damper operation to maintain a CO₂ setpoint of not more than 750 ppm (adj.).

D. Alarms shall be provided as follows:

- 1. High Zone Carbon Dioxide Concentration: If the zone CO₂ concentration is greater than 1000 ppm (adj.).

E. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

F. Zone Optimal Start: The unit shall use an optimal start algorithm for Morning Start-Up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

G. Occupied:

- 1. When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
- 2. When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).
- 3. When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum heating airflow (adj.) until the zone is satisfied.

H. Unoccupied:

1. When the zone is unoccupied, the zone damper shall control to its minimum unoccupied airflow (adj.).
2. When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
3. When zone temperature is less than its unoccupied heating setpoint, the controller shall enable heating to maintain the zone temperature at the setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the auxiliary heating airflow (adj.) until the zone is satisfied.

I. Reheating Coil Valve:

1. The controller shall measure the zone temperature and modulate the reheating coil valve open on dropping temperature to maintain its heating setpoint.
2. When cold air is available from the AHU and there is no fan present in the box, the zone damper shall modulate to the minimum occupied airflow (adj.). If more heat is required, the zone damper shall modulate to the auxiliary heating airflow (adj.).

J. Discharge Air Temperature: The controller shall monitor the discharge air temperature.

K. Alarms shall be provided as follows:

1. High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
2. Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).

L. Zone Humidity: The controller shall monitor the zone humidity.

M. Alarms shall be provided as follows:

1. High Zone Humidity: If the zone humidity is greater than seventy percent (70%) (adj.).
2. Low Zone Humidity: If the zone humidity is less than thirty-five percent (35%) (adj.).

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Airflow	x								x		x
Discharge Air Temp	x								x		x
Zone Carbon Dioxide PPM	x								x		x
Zone Humidity	x								x		x
Zone Setpoint Adjust	x										x
Zone Temp	x								x		x
Reheating Valve		x							x		x
Zone Damper		x							x		x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Airflow Setpoint					x				x		x
Cooling Setpoint					x				x		x
Heating Setpoint					x				x		x
Zone Carbon Dioxide PPM Setpoint					x				x		x
Heating Mode						x			x		
Schedule								x			
High Discharge Air Temp										x	
High Zone Carbon Dioxide Concentration										x	
High Zone Humidity										x	
High Zone Temp										x	
Low Discharge Air Temp										x	
Low Zone Humidity										x	
Low Zone Temp										x	

3.4 ERV w/HOT WATER COIL

- A. General: The ERV is a constant volume unit serving the fresh air to the VRF units. The ERV consists of factory controls for the supply and exhaust fans, energy wheel, economizer dampers, DX cooling, and Bacnet interface. The BMS shall interface with the Bacnet controls for ERV occupied/unoccupied, temperature setpoint control, and unit monitoring/alarms. The BMS shall directly control the duct mounted HW coil heating sequence.
- B. Temperature Setpoints: Unless otherwise indicated, setpoints listed in the sequence of operation shall be adjustable by the Owner through the BMS graphical interface.
- C. Safeties: Unit shutdown safeties shall be a hardwired interlock, that shuts down the unit and generates an alarm at the BMS. The alarm must be cleared at the BMS prior to restarting the unit. Safety hardwired interlocks are as follows: Fire System/Smoke condition, supply high static condition, return low suction static condition, and temperature low limit condition.

- D. Note: Supply high static and return low static conditions shall be monitored by the BMS through a pressure switch. Upon a high or low duct static condition, the unit shall shutdown through a hardwired interlock and an alarm will be generated within the BMS system. Provide auto reset up to three (3) times with a 2-minute delay on restart, after 3rd trip reset shall be manual at the BMS workstation.
- E. Additional Freeze Safety: Anytime the OA temperature drops below 45°F (adj.), the BMS shall modulate the HW coil valve to maintain a minimum "plenum" temperature of 50°F, as sensed by the HW coil discharge air temperature sensor.
- F. Occupied/Unoccupied Control: The unit will be indexed to operate based on an Owner defined occupied/unoccupied schedule from the BMS. Unit will operate in the following modes: Unoccupied and Occupied Mode.
 1. Unoccupied Mode: When the unit is indexed to the Unoccupied Mode, the supply and exhaust fans shall be off, the outdoor air and exhaust air dampers shall be closed, and the heating and cooling shall be disabled.
 2. Occupied Mode: Prior to indexing the ERU, the BMS shall enable the VRF system to operate. The ERU occupied schedule shall be delayed 5 minutes (adj.) from the start time of the occupied schedule for the VRF system to allow the VRF fans to start operating. Once the ERU is indexed to the Occupied Mode, it shall operate through factory packaged controls.
- G. Supply Fan Control: When the unit is enabled, the supply fan shall ramp up in speed to a constant speed setpoint to maintain the design airflow requirements through the factory packaged VFD.
- H. Exhaust Fan Control: When the unit is enabled, the exhaust fan shall ramp up in speed to a constant speed setpoint to maintain the design airflow requirements through the factory packaged VFD.
- I. Energy Recovery Wheel Control: The energy recovery wheel will be energized when the unit is in the Occupied Mode. If the unit enters the economizer mode, the wheel will be de-energized. When the wheel is operating, a defrost cycle will occur that will disable the wheel for 2 minutes if the outdoor air temperature is below the wheel defrost setpoint and 30 minutes have elapsed since the last defrost cycle.
- J. Economizer Control: The unit is being provided with a factory zero to one hundred percent (0-100%) economizer. On a call for cooling, the OA/RA damper shall modulate as required per the factory economizer control.
- K. Heating Control: The BMS shall also monitor the supply air temperature. If the supply air temperature drops below setpoint, the BMS shall, through the bacnet interface, lockout the DX cooling and then shall modulate the ducted HW coil control valve to satisfy the supply air temperature setpoint as sensed by the BMS supply air sensor.
- L. Alarms: The following items will generate alarms within the BMS.
 1. Factory Alarm Conditions
 2. Smoke Shutdown Alarm
 3. Temperature Low Limit Alarm - Freezestat
 4. High/Low Supply Duct Static Alarm
 5. High/Low Supply Air Temperature (Not in Range)
 6. Supply and Exhaust Fan Status Failure
 7. Clogged Filter Status
 8. High Level Condensate Alarm

9. Exhaust and Outdoor Air Damper Failure
10. Energy Recovery Wheel High Pressure

M. Graphics: The following items will be displayed on the BMS graphics:

1. Complete System Graphic
2. Outdoor Temperature and Humidity
3. Alarm conditions
4. Occupied/Unoccupied Mode
5. Supply Air Temperature and Setpoint
6. Supply Fan Status and Speed
7. Exhaust Fan Status and Speed
8. Exhaust Air Temperature
9. Outdoor and Exhaust Air Damper Position Status
10. Condenser Status
11. Filter Status
12. Energy Wheel Entering and Leaving Air Temperatures
13. Reheat Valve Command Percentage
14. Reheat Coil Discharge Air Temperature

3.5 VRF FAN COIL UNITS

A. BMS contractor shall integrate via BACnet to the FCU Factory Controller. BMS contractor shall provide low voltage control wiring for FCU manufacturer field mounted devices.

B. Building Automation System Interface:

1. BMS contractor shall integrate to FCU BACnet Controller (Procon).
2. Through the Bacnet gateway interface, the BMS shall read available interface points from the VRF control system including, but not limited to the following:
 - a. On/Off Status
 - b. Operating Mode Status
 - c. Error Code
 - d. Filter Status
 - e. Discharge Air Temperature
 - f. Temperature Setpoints

C. Alarms: The following items will generate alarms within the BMS.

1. High Space Temperature (5°F from setpoint with 15-minute delay)
2. Low Space Temperature (5°F from setpoint with 15-minute delay)
3. Condensate High Level Condition

D. Graphics: The following items will be displayed on the BMS graphics:

1. Alarm Conditions
2. Occupied/Unoccupied Mode
3. Space Temperature and Setpoints
4. VRF Interfaced Control Points

3.6 SERVER ROOM - SPLIT SYSTEM

A. BMS Contractor to provide low voltage condenser unit wiring and wiring of manufacturer provided space sensors.

- B. BMS to monitor space temperature. BMS to alarm on high and low space temperature.
 - 1. Alarms shall be provided as follows:
 - a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

END OF SECTION 230993

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Air-vent piping.
6. Safety-valve-inlet and -outlet piping.

- B. Pro-Press or similar types of piping products are **NOT** acceptable.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.
2. RTRP and RTRF with adhesive.
3. Chemical treatment.
4. Grooved joint fittings

- B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

- B. Qualification Data: For Installer.

- C. Welding certificates.

- D. Field quality-control reports.

- E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.
- F. Grooved joint couplings and fittings shall be shown on drawings and product submittals and be specifically identified with the applicable style or series number.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
- C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Hot-Water Heating Piping: 200 psig at 200 deg F.
 - 2. Chilled-Water Piping: 200 psig at 200 deg F.
 - 3. Makeup-Water Piping: 80 psig at 150 deg F.
 - 4. Condensate-Drain Piping: 150 deg F.
 - 5. Air-Vent Piping: 200 deg F.
 - 6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L ASTM B 88, Type M.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.
 - 1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
 - 2. Grooved-End-Tube Couplings: Installation-ready, non-rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, pre-lubricated EPDM gasket rated for minimum 250 deg F for use with housing,

and steel bolts and nuts. Couplings shall be cast with offsetting, angle-pattern bolt pads with keys matching pipe and fitting grooves to provide system rigidity upon visual metal-to-metal pad contact without a torque requirement.

E. Manufacturers:

1. Victaulic
2. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

F. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers:

- a. Victaulic
- b. Substitutions: Under provisions of Section 012500 "Substitution Procedures".

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

3. Couplings: Ductile-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

- a. Rigid Type: Housings 12 inches and smaller shall be installation-ready cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9 upon visual metal-to-metal pad contact

without a torque requirement. Designs that permit gaps or spaces at bolt pads or require a torque (per written manufacturer's installation instructions) as a primary means of achieving joint rigidity not permitted.

- b. Flexible Type: Use in locations where thermal stress relief are required such as expansion loops or piping offsets. In lieu of each flexible connector at major equipment, three (3) flexible couplings may be used for vibration attenuation and shall be placed in close proximity to the vibrating source.
- c. Gaskets: Grade EHP EPDM for NPS 12 and smaller and Grade E EPDM for NPS 14 and larger.

- I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441, with wall thickness as indicated in "Piping Applications" Article.

- 1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

2.5 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

- 1. ASME B16.21, non-metallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

- a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
- b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

- G. Solvent Cements for Joining Plastic Piping:

- 1. CPVC Piping: ASTM F 493.

- a. CPVC solvent cement shall have a VOC content of 490 g/L or less.
- b. Adhesive primer shall have a VOC content of 550 g/L or less.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating non-conductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 150 psig.
- D. Dielectric-Flange Insulating Kits:
 - 1. Description:
 - a. Non-conducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and non-corrosive, propylene.

2.7 BYPASS CHEMICAL FEEDER

- A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
 - 1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40, Grade B, Type 96 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- C. Hot-water heating piping installed belowground and within slabs shall be the following:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
- D. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- E. Chilled-water piping, aboveground, NPS 2-1/2, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- F. Chilled-water piping installed belowground and within slabs shall be the following:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and brazed joints. Use the fewest possible joints.
 2. Pre-insulated plastic-jacketed piping, welded ends.
- G. Makeup-water piping installed aboveground shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- H. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- I. Air-Vent Piping:
1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 2. Outlet: Type K annealed-temper copper tubing with soldered joints.
- J. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install General Duty valves according to Related Sections.
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges or grooved joint couplings in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install shutoff valve immediately upstream of each dielectric fitting.
- S. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples].
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Piping Hanger Spacing: Refer to the Drawings and Schedules.
- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel or groove plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. CPVC Piping: Join according to ASTM D 2846 Appendix.
 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
 4. PVC Non-pressure Piping: Join according to ASTM D 2855.
- I. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid or flexible (as required), grooved-end-pipe couplings. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. A factory-trained field representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved piping products.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

- A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
1. pH: 9.0 to 10.5.
 2. "P" Alkalinity: 100 to 500 ppm.
 3. Boron: 100 to 200 ppm.
 4. Chemical Oxygen Demand: Maximum of 100 ppm.

5. Corrosion Inhibitor:
 - a. Sodium Nitrate: 1000 to 1500 ppm.
 - b. Molybdate: 200 to 300 ppm.
 - c. Chromate: 200 to 300 ppm.
 - d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
 - e. Chromate Plus Molybdate: 50 to 100 ppm each.
6. Soluble Copper: Maximum of 0.20 ppm.
7. Tolyriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of 10 ppm.
8. Total Suspended Solids: Maximum of 10 ppm.
9. Ammonia: Maximum of 20 ppm.
10. Free Caustic Alkalinity: Maximum of 20 ppm.
11. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maximum of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maximum of 100 organisms/mL.
 - c. Nitrate Reducers: 100 organisms/mL.
 - d. Sulfate Reducers: Maximum of zero organisms/mL.
 - e. Iron Bacteria: Maximum of zero organisms/mL.

B. Install bypass chemical feeders in each hydronic system where indicated.

1. Install in upright position with top of funnel not more than 48 inches above the floor.
2. Install feeder in minimum NPS 3/4 (DN 20) bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
3. Install NPS 3/4 (DN 20) pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.

C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed ninety percent (90%) of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 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 special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Air-vent piping.
6. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 2. Air-control devices.
 3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 1. Hot-Water Heating Piping: 200 psig at 200 deg F.
 2. Chilled-Water Piping: 200 psig at 200 deg F.

3. Makeup-Water Piping: 80 psig at 150 deg F.
4. Condensate-Drain Piping: 150 deg F.
5. Air-Vent Piping: 200 deg F.
6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements related Sections for "General Duty Valves."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements related Sections for "Control Valves."
- C. Bronze, Combination Balancing & Shutoff Valves:
 1. Manufacturers:
 - a. Armstrong
 - b. Bell & Gossett
 - c. Tour & Andersson/Victaulic
 2. Body: Bronze, Y-pattern globe valve ball or plug type with calibrated orifice or venturi.
 3. Ball: Brass or stainless-steel.
 4. Plug: Resin.
 5. Seat: PTFE.
 6. End Connections: Threaded or socket.
 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 8. Handle Style: Lever, Digital handwheel with concealed memory stop to retain set position.
 9. CWP Rating: Minimum 125 psig.
 10. Maximum Operating Temperature: 250 deg F.
 11. Coil kit assemblies may be used to reduce space requirements and the number of joints
- D. Cast-Iron, Ductile-Iron or Steel, Calibrated-Orifice, Combination Balancing & Shutoff Valves:
 1. Manufacturers:
 - a. Armstrong
 - b. Bell & Gossett
 - c. Tour & Andersson/Victaulic
 2. Body: Cast-iron, ductile-iron or steel body, ball, plug, or globe Y-pattern with calibrated orifice or venturi.
 3. Ball: Brass or stainless-steel.
 4. Stem Seals: EPDM O-rings.
 5. Disc: Glass and carbon-filled PTFE.
 6. Seat: PTFE or EPDM.
 7. End Connections: Flanged or grooved.
 8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 9. Handle Style: Lever, Digital handwheel with concealed memory stop to retain set position.
 10. CWP Rating: Minimum 125 psig.
 11. Maximum Operating Temperature: 250 deg F.
 12. Coil kit assemblies may be used to reduce space requirements and the number of joints.
- E. Differential Pressure Controller.

1. Manufacturers:
 - a. Victaulic Tour & Andersson STAP
 - b. Substitution: Under provisions of Section 012500 "Substitution Procedures".
 2. Body: Copper alloy (½- to 2-inch) and ductile-iron (2½-inch and larger).
 3. Membrane: HNBR or EPDM.
 4. End Connections: Threaded or flanged.
 5. Capillary tube, hose kit, and all connection fittings shall be manufactured by controller manufacturer to ensure proper operation of installed STAP valves. Mechanical contractor and balancing contractor shall be trained on installation, connection, and balancing procedures by certified a factory representative.
- F. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Body: Bronze or brass.
 2. Disc: Glass and carbon-filled PTFE.
 3. Seat: Brass.
 4. Stem Seals: EPDM O-rings.
 5. Diaphragm: EPT.
 6. Low inlet-pressure check valve.
 7. Inlet Strainer: Stainless-steel, removable without system shutdown.
 8. Valve Seat and Stem: Non-corrosive.
 9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- G. Diaphragm-Operated Safety Valves: ASME labeled.
1. Body: Bronze or brass.
 2. Disc: Glass and carbon-filled PTFE.
 3. Seat: Brass.
 4. Stem Seals: EPDM O-rings.
 5. Diaphragm: EPT.
 6. Wetted, Internal Work Parts: Brass and rubber.
 7. Inlet Strainer: Stainless-steel, removable without system shutdown.
 8. Valve Seat and Stem: Non-corrosive.
 9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- H. Automatic Flow-Control Valves:
1. Manufacturers:
 - a. Griswold
 - b. Nexus
 - c. Victaulic
 2. Body: Brass or ferrous metal.
 3. Piston and Spring Assembly: Stainless-steel, tamper proof, self-cleaning, and removable.
 4. Combination Assemblies: Include bronze or brass-alloy ball valve.
 5. Identification Tag: Marked with zone identification, valve number, and flow rate.
 6. Size: Same as pipe in which installed.
 7. Performance: Maintain constant flow, plus or minus five percent (+/-5%) over system pressure fluctuations.

8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Non-ferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Non-ferrous.
3. Operator: Non-corrosive metal float.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/4 (DN 8).
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

C. Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Tank Drain Fitting: Brass body, non-ferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.

D. Diaphragm-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig.
3. Maximum Operating Temperature: Up to 300 deg F.

F. Air Purgers:

1. Body: Cast iron with internal SS pall rings that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.

2. Maximum Working Pressure: 150 psig.
3. Maximum Operating Temperature: 250 deg F.

2.4 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged or grooved ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 60-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

C. Hydraulic Separators:

1. Manufacturers, supply as listed below:
 - a. Bell & Gossett, Xylem
 - b. Caleffi HydoCal (Basis-of-Design)
 - c. Taco
2. Units shall provide air, dirt and hydraulic separation for the maximum flow rate range per the systems served, and shall be as follows:
 - a. Epoxy-resin coated steel body.
 - b. Factory-installed pre-formed insulation.
 - c. Type 304L stainless-steel internals.
 - d. ANSI 150# Class flanged connections.
3. Furnished complete with:
 - a. Automatic air vent.
 - b. Air vent shut-off valve.
 - c. Drain valve.
 - d. Floor stand with anchors.

D. On Victaulic grooved installations, three (3) flexible style couplings may be used in lieu of each flexible connector for vibration attenuation at major equipment. Couplings shall be placed in close proximity to the vibrating source in accordance with published guidelines.

E. Expansion Fittings: Comply with requirements in Sections Related to "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install calibrated-orifice or Y-pattern balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, Y-pattern balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install drain valves with cap and chain at all system low points.
- D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a two percent (2%) upward slope toward tank.
- E. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- F. Install hydraulic separators with isolation valves at each point of connection. Anchor to 4-inch-thick, concrete housekeeping pad.
- G. Install expansion tanks on the floor. Vent and purge air from hydronic system and ensure that tank is properly charged with air to suit system Project requirements.
- H. Install flexible connections at connections of piping to all equipment.

END OF SECTION 232116

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Piping.
2. Refrigerant.
3. Moisture and liquid indicators.
4. Valves.
5. Strainers.
6. Check valves.
7. Pressure regulators.
8. Pressure relief valves.
9. Filter-driers.
10. Solenoid valves.
11. Expansion valves.
12. Receivers.
13. Flexible connections.

- B. Pro-Press or similar types of piping products are **NOT** acceptable.

1.3 REFERENCE STANDARDS (FOLLOW THE MOST CURRENTLY ADOPTED AMENDED VERSION)

- A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):

1. 495 - Performance Rating of Refrigerant Liquid Receivers
2. 710 - Performance Rating of Liquid-Line Driers.
3. 730 (I-P) - Flow Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers
4. 750 - Thermostatic Refrigerant Expansion Valves
5. 760 - Performance Rating of Solenoid Valves for Use with Volatile Refrigerants

- B. American Society of Heating, Refrigerating, and Air-Conditioning (ASHRAE):

1. Std 15 - Safety Standard for Refrigeration Systems
2. Std 34 - Designation and Safety Classification of Refrigerants

- C. American Society of Mechanical Engineers (ASME):

1. BPVC-VIII-1 - Boiler and Pressure Vessel Code Section VIII Division 1 - Rules for Construction of Pressure Vessels
2. BPVC-IX - Boiler and Pressure Vessel Code Section IX - Welding Brazing and Fusing Qualifications
3. B16.22 - Wrought Copper and Copper Alloy Solder-Joint.
4. B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes

- 5. B31.5 - Refrigeration Piping and Heat Transfer Components
- 6. B31.9 - Building Services Piping

D. American Society for Testing and Materials (ASTM):

- 1. A 53 - Standard Specification for Pipe Steel Black and Hot-Dipped Zinc-Coated Welded and Seamless
- 2. A 123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- 3. A 234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
- 4. B 88 - Standard Specification for Seamless Copper Water Tube
- 5. B 280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
- 6. F 708 - Standard Practice for Design and Installation of Rigid Pipe Hangers

E. American Welding Society (AWS):

- 1. A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- 2. D1.1 - Structural Welding Code – Steel

F. MSS SP-58 - Pipe Hangers and Supports - Materials Design Manufacture Selection Application and Installation

G. Underwriters Laboratories (UL):

- 1. 429 - Electrically Operated Valves; Current Edition Including All Revisions.

1.4 SYSTEM DESCRIPTION

A. Where more than one (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 unions and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASME B31.5 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 service valves on suction and discharge of evaporators.
- 3. Use gauge taps at compressor inlet and outlet.
- 4. Use gauge taps at hot gas bypass regulators inlet and outlet.
- 5. Use check valves on compressor discharge.
- 6. 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. Use shut-off valve on each side of strainer.

G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.

H. Filter-Driers:

1. Use a filter-drier immediately ahead of liquid-line controls such as thermostatic expansion valves solenoid valves and moisture indicators.
2. Use a filter-drier on suction line just ahead of compressor.
3. Use sealed filter-driers in lines smaller than ½-inch outside diameter.
4. Use sealed filter-driers in low-temperature systems.
5. Use sealed filter-driers in systems utilizing hermetic compressors.
6. Use replaceable core filter-driers in lines of ½-inch outside diameter or greater.

I. 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 the flow of oil and refrigerant into the suction line when the system shuts down.

J. Receivers:

1. Use on systems 10 tons and larger sized to accommodate pump-down charge.
2. Use on systems with long piping runs.

K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

- A. Product Data: Provide general assembly of specialties including manufacturer's catalogue information. Provide manufacturers catalog data including load capacity.
- B. Shop Drawings: Indicate schematic layout of system including equipment critical dimensions equivalent piping lengths and sizes.
- C. Design Data: Submit design data indicating pipe sizing. Indicate load-carrying capacity of trapeze multiple pipe and riser support hangers.
- D. Test Reports: Indicate results of leak test acid test.
- E. Manufacturer's Installation Instructions: Indicate support connection requirements and isolation for servicing.
- F. Submit welders certification of compliance with ASME BPVC-IX.
- G. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

- H. Maintenance Data: Include instructions for changing cartridges assembly views spare parts lists.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of the project.
 - 1. Extra Filter-Drier Cartridges: One (1) of each type and size.
 - 2. Refrigeration Oil Test Kits: One (1) each containing everything required to conduct one (1) test.
 - 3. Extra Refrigerant: One (1) container of refrigerant 5-pound size.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall have the following responsibilities:
 - 1. Note: Pipe sizes and routing on drawings are shown for reference only and based on listed manufacturer's equipment only.
 - 2. Determine coordination and final routing sizes and locations of all system piping and components.
 - 3. Coordinate system requirements valves driers and accessories for complete system with equipment manufacturer.
 - 4. Calculate total system volume and refrigerant charge required for proper operation.
 - 5. Provide installation instructions drawings and field supervision to assure proper installation and performance.

1.7 QUALITY ASSURANCE

- A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum five (5) years of documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers seal prior to shipment until connected into system.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.
- C. Welders Certification: In accordance with ASME BPVC-IX.

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

2.2 PIPING

- A. Copper Tube: ASTM B 280, Type ACR, hard drawn or annealed.
- B. Fittings: ASME B16.22, wrought copper.
- C. Joints: Braze AWS A5.8, BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.3 REFRIGERANT

- A. Refrigerant: Based on equipment schedules on Drawings.

2.4 MOISTURE AND LIQUID INDICATORS

- A. Manufacturers:
 - 1. Henry Technologies
 - 2. Parker Hannifin/Refrigeration and Air Conditioning
 - 3. Sporlan a Division of Parker Hannifin
- B. Indicators: Single port type UL listed with copper or brass body flared or solder ends sight glass color-coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.5 VALVES

- A. Manufacturers:
 - 1. Flomatic Valves
 - 2. Hansen Technologies Corporation
 - 3. Henry Technologies
- B. Diaphragm Packless Valves: 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 psi and maximum temperature of 275 degrees F.
- C. Packed Angle Valves: Forged brass or nickel-plated forged steel 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 psi and maximum temperature of 275 degrees F.
- D. Ball Valves: Two-piece bolted 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 psi and maximum temperature of 300 degrees F.
- E. Service Valves: Forged brass body with copper stubs brass caps removable valve core integral ball check valve flared or solder ends for maximum pressure of 500 psi.

2.6 STRAINERS

- A. Manufacturers:

1. Hansen Technologies Corporation
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan a Division of Parker Hannifin

- B. Straight Line or Angle Line Type: 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 psi.

2.7 CHECK VALVES

- A. Manufacturers:

1. Hansen Technologies Corporation
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan a Division of Parker Hannifin

- B. Globe Type: 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 temperature of 300 degrees F and maximum working pressure of 425 psi.

- C. Straight Through Type: Brass body and disc phosphor-bronze or stainless-steel spring neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.8 PRESSURE REGULATORS

- A. Manufacturers:

1. Hansen Technologies Corporation
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan a Division of Parker Hannifin

- B. Brass body stainless steel diaphragm direct acting adjustable over 0 to 80 psi range for maximum working pressure of 450 psi.

2.9 PRESSURE RELIEF VALVES

- A. Manufacturers:

1. Hansen Technologies Corporation
2. Henry Technologies
3. Sherwood Valve/Harsco Corporation

- B. Straight Through or Angle Type: Brass body and disc neoprene seat factory sealed and stamped with ASME UV and National Board Certification NB selected to ASHRAE Std 15 with standard setting of 235 psi.

2.10 FILTER-DRIERS

- A. Manufacturers:

1. Flow Controls Division of Emerson Electric
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan a Division of Parker Hannifin

B. Performance:

1. Flow Capacity - Liquid Line: Size per approved equipment capacity rated in accordance with AHRI 710.
2. Flow Capacity - Suction Line: Size per approved equipment capacity rated in accordance with AHRI 730 (I-P).
3. Water Capacity: Size per approved equipment capacity rated in accordance with AHRI 710.
4. Water Capacity: As indicated in schedule rated in accordance with AHRI 710.
5. Pressure Drop: 2 psi maximum when operating at full connected evaporator capacity.
6. Design Working Pressure: 350 psi minimum.

C. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant activated alumina activated charcoal and filtration to 40 microns with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

D. Construction: UL listed.

1. Replaceable Core Type: Steel shell with removable cap.
2. Sealed Type: Copper shell.
3. Connections: As specified for applicable pipe type.

2.11 SOLENOID VALVES

A. Manufacturers:

1. Flow Controls Division of Emerson Electric
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan a Division of Parker Hannifin

B. Valve: AHRI 760 I-P pilot operated copper brass or steel body and internal parts synthetic seat stainless steel stem and plunger assembly (permitting manual operation in case of coil failure) integral strainer with flared solder or threaded ends; for maximum working pressure of 500 psi.

C. Coil Assembly: UL 429 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.

2.12 EXPANSION VALVES

A. Manufacturers:

1. Flow Controls Division of Emerson Electric
2. Parker Hannifin/Refrigeration and Air Conditioning
3. Sporlan a Division of Parker Hannifin

B. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant brass body internal or external equalizer bleed hole adjustable superheat setting replaceable inlet strainer with non-replaceable capillary tube and remote sensing bulb and remote bulb well.

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 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.13 ELECTRONIC EXPANSION VALVES

- A. Manufacturers:
 - 1. Flomatic Valves
 - 2. Parker Hannifin/Refrigeration and Air Conditioning
 - 3. Sporlan a Division of 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: Compatible with compressor size it serves.
- C. Evaporation Control System: Electronic microprocessor-based unit in enclosed case proportional integral control with adaptive superheat maximum operating pressure function pre-selection allowance for electrical defrost and hot gas bypass.
- 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.

2.14 RECEIVERS

- A. Manufacturers:
 - 1. Henry Technologies
 - 2. Parker Hannifin/Refrigeration and Air Conditioning
 - 3. Sherwood Valve/Harsco Corporation.
- B. Internal Diameter 6-Inch and Smaller: AHRI 495 UL listed steel brazed; 400 psi maximum pressure rating with tappings for inlet outlet and pressure relief valve.
- C. Internal Diameter Over 6-Inch: AHRI 495 welded steel tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves pressure relief valve and magnetic liquid level indicator.

2.15 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Circuit Hydraulics Ltd
 - 2. Flexicraft Industries
 - 3. Penflex
- B. Corrugated stainless-steel hose with single layer of stainless-steel exterior braiding minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

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 with piping parallel to building structure and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations.
- 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.
 - 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 above slab.
- G. Arrange piping to return oil to compressor. Provide traps and loops in piping and provide double risers as required.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Flood piping system with nitrogen when brazing.
- J. Where pipe support members are welded to structural building frame, brush clean and apply one (1) coat of zinc-rich primer to welding.
- K. Prepare unfinished pipe fittings supports and accessories ready for finish painting. Refer to Division 09 – Finishes.
- L. Insulate piping and equipment; refer to Section 230700 "HVAC Insulation".
- M. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- N. Provide replaceable cartridge filter-driers with isolation valves and valved bypass.
- O. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- P. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- Q. Install flexible connectors at right angles to axial movement of compressor parallel to crankshaft.

- R. Fully charge completed system with refrigerant after testing.
- S. Provide electrical connection to solenoid valves. Refer to Division 26.

3.3 FIELD QUALITY CONTROL

- A. See Division 01 – General Requirements.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test system with dry nitrogen to maximum allowable working pressure. Pressure shall hold for a minimum of 24 hours with no leakage allowed.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Double-wall round ducts and fittings.
4. Sheet metal materials.
5. Duct lagging material.
6. Sealants and gaskets.
7. Hangers and supports.
8. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.

4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
13. Preparation for selecting hangers and supports and seismic restraints.

C. Coordination Drawings: Plans, drawn to 1/4-inch scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.

D. Welding certificates.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC
 - c. SEMCO Incorporated
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL SPIRAL ROUND DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Lindab Inc.
 - 2. McGill AirFlow LLC
 - 3. SEMCO Incorporated
 - 4. Sheet Metal Connectors, Inc.

- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 - 1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Inner Duct: Minimum 0.028-inch solid sheet steel.
- D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: 0.13 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2. Insulation Thickness: 2 inches.
 - 3. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 4. Coat insulation with antimicrobial coating.
 - 5. Cover insulation with polyester film complying with UL 181, Class 1.

2.4 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008, with oiled, matte finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- E. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

- F. Tie Rods: Galvanized steel, ¼-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 DUCT LAGGING MATERIAL

- A. General: Flexible barrier material for wrapping ducts to lower break-out noise from turbulent air.
- B. Nominal Density: 1 lb./sq. ft.
- C. Thickness: 0.10-inch.
- D. The barrier is barium loaded high mass, limp vinyl bonded to a reinforced aluminum foil facing one (1) side; Under Industries **Model DL-10-LAG** or equivalent.

- E. Sound Transmission Loss: dB

Hz	125	250	500	1000	2000	4000	STC
dB	15	19	21	29	33	37	27

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

- B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

- C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum sixty-five percent (65%).
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless-steel, or aluminum sheets.

- D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.

3. Solvent: Toluene and heptane.
4. Solids Content: Minimum sixty percent (60%).
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

H. Dissimilar Duct Metals: EPDM O-ring and gaskets are to be used for dissimilar duct material.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Non-corrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.8 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries
 - 2. Ductmate Industries, Inc.
 - 3. Hilti Corp.
 - 4. Kinetics Noise Control
 - 5. Loos & Co.; Cableware Division
 - 6. Mason Industries
 - 7. TOLCO; a brand of NIBCO INC.
 - 8. Unistrut Corporation; Tyco International, Ltd.
- B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one (1) end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- C. Restraint Cables ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. All ductwork shall be galvanized steel except as follows:
 - 1. Toilet Area: Aluminum.
 - 2. Janitors Closet: Aluminum.

3.2 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four (4) sides by at least 1½ inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."
- M. Install acoustic lagging material where indicated on plans.

3.3 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless-steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.

5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg : Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.

- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.7 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one (1) coat of flat, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections. Color choice by Architect and Owner from manufacturer's entire range.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than fifty percent (50%) of total installed duct area for each designated pressure class.
 - b. Return Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than fifty percent (50%) of total installed duct area for each designated pressure class.

- c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than fifty percent (50%) of total installed duct area for each designated pressure class.
 - d. Outdoor Air Ducts with a Pressure Class of 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than fifty percent (50%) of total installed duct area for each designated pressure class.
- 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 6. Give seven (7) days' advance notice for testing.

3.10 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

- B. Supply Ducts:

- 1. Ducts Connected to Fan Coil Units:
 - a. Pressure Class: Positive 1-inch wg.
- 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.

- C. Return Ducts:

- 1. Ducts Connected to Fan Coil Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
- 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg.

- D. Exhaust Ducts:

- 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.

- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

- 1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Aluminum Ducts: Aluminum.

G. Liner:

1. Supply Air Ducts Within the Building Envelop: Fibrous glass, Type I, 2 inches thick.
2. Return Air Ducts Within the Building Envelop: Fibrous glass, Type I, 2 inches thick.
3. Transfer Ducts: Fibrous glass, Type I, 2 inches thick.
4. Supply Air Ducts Outside of the Building Envelop: Fibrous glass, Type I, 3 inches thick.
5. Return Air Ducts Outside of the Building Envelop: Fibrous glass, Type I, 3 inches thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two (2) vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two (2) vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered

Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

- 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three (3) segments for 90-degree elbow.
- 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four (4) segments for 90-degree elbow.
- 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five (5) segments for 90-degree elbow.
- 4) Radius-to Diameter Ratio: 1.5.

- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
- c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Ceiling dampers.
6. Smoke dampers.
7. Combination fire and smoke dampers.
8. Flange connectors.
9. Turning vanes.
10. Remote damper operators.
11. Duct-mounted access doors.
12. Flexible connectors.
13. Flexible ducts.
14. Duct accessory hardware.

B. Related Requirements:

1. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

- e. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to ten percent (10%) of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" latest edition for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with International Mechanical Code and Connecticut State Mechanical Code.

2.2 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" latest edition for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized or galvanized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Material shall match components, minimum 3/8-inch.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Greenheck Fan Corporation
 - 2. Nailor Industries Inc.
 - 3. Pottorff
 - 4. Ruskin Company
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: Hat-shaped, 0.063-inch-thick extruded aluminum, with welded corners or mechanically attached and mounting flange.
- F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
 - 1. Material: Aluminum.
 - 2. Diameter: 0.20-inch.
- J. Tie Bars and Brackets: Aluminum.
- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball or synthetic pivot bushings.
- M. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20 gage minimum.
 - b. Sleeve Length: 6 inches minimum.
 - 6. Screen Material: Aluminum.

7. Screen Type: Insect.
8. 90-degree stops.

2.4 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Greenheck Fan Corporation
 2. Nailor Industries Inc.
 3. Pottorff
 4. Ruskin Company
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 1000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: Hat-shaped, 0.063-inch-thick extruded aluminum, with welded corners or mechanically attached and mounting flange.
- F. Blades:
 1. Multiple, 0.050-inch-thick aluminum sheet.
 2. Maximum Width: 6 inches.
 3. Action: Parallel.
 4. Balance: Gravity.
- G. Blade Seals: Neoprene.
- H. Blade Axles: Non-ferrous metal.
- I. Tie Bars and Brackets:
 1. Material: Aluminum.
 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic, stainless-steel or bronze.
- L. Accessories:
 1. Flange on intake.
 2. Adjustment device to permit setting for varying differential static pressures.
 3. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
 4. Screen Material: Aluminum.
 5. Screen Type: Insect.

2.5 MANUAL VOLUME DAMPERS

- A. Single Blade Dampers. Maximum width of single blade shall be 14 inches, use opposed blade damper for height exceeding 14 inches. Pre-manufactured dampers shall be part of an assembly complete with damper, frame, axle and bearings. The damper frame shall be installed internal to the duct and fastened with the appropriate hardware. The installation shall not interfere with the operation of the damper blade(s).
- B. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Rectangular:
 - a. Air Balance; **AC-111**
 - b. Greenheck; **MBD-10**
 - c. Ruskin; **MD25**
 - 2. Round:
 - a. Air Balance; **AC-112**
 - b. Greenheck; **MBDR50**
 - c. Ruskin; **MDRS25**
- C. Multiple Blade Dampers. Opposed blade damper shall be used where duct height exceeds 14 inches. Approved products for pre-manufactured devices are as follows:
 - 1. Opposed Blade:
 - a. Air Balance; **AC-2**
 - b. Greenheck; **MBD-15**
 - c. Ruskin; **MD35OB**
- D. Steel, Manual Volume Dampers: Except for outdoor air.
 - 1. Linkage outside airstream.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames:
 - a. Hat shaped.
 - b. Galvanized-steel channels, 0.064-inch-thick.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4. Blades:
 - a. Parallel- or opposed-blade design.
 - b. Stiffen damper blades for stability.
 - c. Galvanized, roll-formed steel, 0.064-inch-thick.
 - 5. Blade Axles: Galvanized steel.
 - 6. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Jamb Seals: Cambered aluminum.
8. Tie Bars and Brackets: Aluminum.
9. Accessories:

- a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- b. Include standoffs for insulated ductwork.

E. Aluminum, Manual Volume Dampers: For outdoor air.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. McGill AirFlow LLC
 - b. Pottorff; a division of PCI Industries, Inc.
 - c. Ruskin Company
2. Linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Parallel- or opposed-blade design.
 - b. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
 - c. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
6. Blade Axles: Galvanized steel.
7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Jamb Seals: Cambered aluminum.
9. Tie Bars and Brackets: Aluminum.
10. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
 - b. Include standoffs for insulated ductwork.

F. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

G. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.

- H. All dampers shall be furnished with an elevated platform/standoff for insulated duct mounting.
- I. Provide dampers in all branch ducts and duct splits whether indicated or not on the drawings.

2.6 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Greenheck Fan Corporation **DFD-211 / DFDR-511, DFD-231 / DFDR-531**
 - 2. Nailor Industries Inc.
 - 3. Ruskin Company **DIBDX, IBDT, DIBDXGA**
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1½ and 3 hours.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.39-inch-thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.
- K. Grille Access Fire Dampers shall be provided where sidewall grilles are mounted to a fire rated wall.
- L. Provide dampers; as required by all local and state codes; in ducts whether indicated or not on the drawings.

2.7 CEILING DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Greenheck Fan Corporation
 - 2. Nailor Industries Inc.
 - 3. Price
 - 4. Ruskin Company
 - 5. Titus
- B. General Requirements:

1. Labeled according to UL 555C by an NRTL.
2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

- C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- D. Blades: Galvanized sheet steel with refractory insulation.
- E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- F. Fire Rating: 2 or 3 hours as required to maintain fire rating.

2.8 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 1. Greenheck Fan Corporation **SMD-201 / SMDR-501**
 2. Nailor Industries Inc.
 3. Ruskin Company **SD-60 / SDRS25**
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Smoke Detector: Provided by Division 28, installed by Division 23 and wired by Division 26.
- D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- F. Leakage: Class I.
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- I. Damper Motors: Modulating or two-position action.
- J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 6. Non-Spring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 7. Electrical Connection: 115 V, single phase, 60 Hz.
- K. Grille Access Smoke dampers shall be provided where sidewall grilles are mounted to a smoke rated wall.
- L. Accessories:
1. Auxiliary switches for signaling.
 2. Test and reset switches, remote mounted.
- M. Provide dampers; as required by all local and state codes; in ducts whether indicated or not on the Drawings.
- 2.9 COMBINATION FIRE AND SMOKE DAMPERS
- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Greenheck Fan Corporation; **FSD33 w/TOR**
 2. Nailor Industries Inc.
 3. Ruskin Company; **FSD60 w/TS-150, FSD60FA w/TS-150**
 4. Air Balance Inc.; **FA1 w/Sens-O-Therm**
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1½ hours.
- E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
- G. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- H. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Leakage: Class I.
- J. Rated pressure and velocity to exceed design airflow conditions.
- K. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- L. Master control panel for use in dynamic smoke-management systems.
- M. Damper Motors: Modulating or two-position action.

- N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Non-Spring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- O. Grille Access Fire/Smoke dampers shall be provided where sidewall grilles are mounted to a smoke rated wall.
- P. Accessories:
 - 1. Auxiliary switches for signaling.
 - 2. Test and reset switches, damper mounted.
- Q. Provide dampers; as required by all local and state codes; in ducts whether indicated or not on the Drawings.

2.10 CORRIDOR DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Ruskin Company
 - 2. Greenheck Fan Corporation
 - 3. Nailor Industries Inc.
- B. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1½-hour rating by an NRTL.
- C. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- D. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.
- E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

- G. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application.
- H. Damper Motors: Two-position action.
- I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Non-Spring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.

2.11 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.12 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

- B. Manufacturers Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows" unless otherwise noted.
- D. Vane Construction: Turning vanes shall be double wall construction of minimum 24-gauge galvanized metal. Each vane shall be securely riveted or welded to minimum 22-gauge runner or directly to duct.
- E. Turning vanes shall have 2-inch inside radius spaced 2-1/8 inches apart through 24-inch-wide duct. Vanes in elbows larger than 24 inches shall have a 4½-inch radius and be spaced 3¼ inches apart.
- F. Vanes shall be installed in sections to reduce unsupported length for duct depths exceeding 60 inches.

2.13 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. DuroDyne
 - 2. Metropolitan Air
 - 3. Young Regulator
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless-steel.
- E. Cable operated dampers (COD) shall be provided where indicated on plans, and/or where required due to damper location above/behind finished construction, where access to damper would require access door in finished construction.
- F. Provide cable operated dampers in branch duct serving diffusers in inaccessible ceiling locations whether indicated or not on the Drawings.
- G. Cable shall terminate within the face of each diffuser/register/grille. Damper shall be adjustable through the face of the diffuser/register/grille with standard tools.
- H. Furnish all required duct penetration seal plates, gaskets, bearings, retainers, and cable to duct mounting clamps.
- I. Cable lengths shall be coordinated to allow damper to be placed at the branch duct take-off immediately off the main. Dampers shall be located as far as possible from the terminal outlet/diffuser.
- J. Wall-Box Mounting: Recessed.
- K. Wall-Box Cover-Plate Material: Steel.

2.14 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Ductmate Industries, Inc.
 2. Greenheck Fan Corporation
 3. McGill AirFlow LLC
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct" unless otherwise noted.
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Hinges: 1-by-1-inch butt or piano hinge and latches.
 - d. Latches: Similar to Ventfabrics, Inc. **No. 100** for small doors and **No. 310** where physical access is possible. Window latch/sash type hardware is specifically prohibited except where the door swing for a hinged door is restricted by the hung ceiling or some other obstruction.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two (2) latches.
 - b. Access Doors up to 18 Inches Square: Two (2) hinges and two (2) latches.
 - c. Access Doors up to 24 by 48 Inches: Three (3) hinges and two (2) latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four (4) hinges and two (2) latches with outside and inside handles.
 4. Access doors shall be rated to maintain the fire/smoke rating of the equipment/duct in which they are installed.
- C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
 2. Door: Single wall with metal thickness applicable for duct pressure class.
 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 4. Factory set at 3.0- to 8.0-inch wg.
 5. Doors close when pressures are within set-point range.
 6. Hinge: Continuous piano.
 7. Latches: Cam.
 8. Seal: Neoprene or foam rubber.
 9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.15 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Ductmate Industries, Inc.
2. Flame Gard, Inc.
3. 3M

- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.16 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
- B. Materials: Flame-retardant or non-combustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5¾ inches wide attached to 2 strips of 2¾-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 1. Minimum Weight: 26 oz./sq. yd.
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 1. Minimum Weight: 24 oz./sq. yd.
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 1. Minimum Weight: 16 oz./sq. yd.
 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F.
- H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
3. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
4. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
5. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of ¼-inch movement at start and stop.

2.17 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
- C. Flexible Duct Connectors:
 1. Clamps: Stainless-steel strap in sizes 3 through 18 inches to suit duct size.
- D. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

2.18 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

- C. Install motorized dampers at the discharge of exhaust fans or exhaust ducts as close as possible to the exhaust outlet unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Provide volume dampers in each branch duct serving diffuser whether indicated or not.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated and as required.
- H. Install fire and smoke dampers according to UL listing.
- I. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and ½-inch-diameter steel bars, 6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2½-by-2½-by-¼-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.
- J. Connect ducts to duct silencers rigidly.
- K. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. On both sides of duct coils.
 2. Upstream from duct filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. At each change in direction and at maximum 50-foot spacing.
 8. Upstream and downstream from turning vanes.
 9. Upstream or downstream from duct silencers.
 10. Control devices requiring inspection.
 11. Elsewhere as indicated.
- L. Install access doors with swing against duct static pressure.
- M. Access Door Sizes:
 1. One-Hand or Inspection Access: 12 by 12 inches.
 2. Two-Hand Access: 12 by 12 inches.
 3. Head and Hand Access: 20 by 16 inches.

- 4. Head and Shoulders Access: 24 by 24 inches.
- 5. Body Access: 24 by 24 inches.
- 6. Body plus Ladder Access: 24 by 24 inches.

- N. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

- O. Locate all duct balancing dampers above accessible ceilings, or provide cable operated dampers.

- P. Install flexible connectors to connect ducts to equipment.

- Q. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

- R. Install duct test holes where required for testing and balancing purposes.

- S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of ¼-inch movement during start and stop of fans.

- T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of ¼-inch movement during start and stop of fans.

3.2 FLEXIBLE DUCT

- A. Flexible duct sections shall not exceed 4 feet fully extended.
- B. Flexible ductwork shall not be used for offsets or elbows.
- C. Joints shall be made with a minimum 2-inch overlap lined with **EC800** mastic and sealed with metal clamps.
- D. Flexible ductwork shall only be used for branch duct to diffuser connections when indicated as an acceptable connector on the mechanical drawing details.
- E. Connections from branch duct to diffuser necks shall be rigid sheet metal unless otherwise noted on the drawing details.
- F. Flexible ductwork shall be supported in accordance with SMACNA Figure 3-10 and 3-11 "Flexible Duct Supports". A minimum of two (2) 1-inch-wide metal straps shall be used. Wire hanging is not acceptable.

3.3 TEST CONNECTIONS

- A. On the discharge duct from each air handling unit downstream at least 5 feet from unit if duct is accessible, or closer to unit if necessary, install a **#699** Ventlock instrument test hold device for balancing and testing of system.

3.4 ACCESS DOORS IN WALLS AND CEILINGS

- A. At each control and balancing damper in ductwork, at each fire damper and volume box, when located above ceiling or inside the wall not accessible by removal of grille or from the airshafts, furnish an access door for installation by the Contractor. Access doors shall be 18 inches x 18

inches (minimum) unless otherwise indicated on plans. In plenum ceilings, provide felt between the door and frame to make an air tight seal.

- B. All access panel locations shall be shown on the Coordination Drawings.
- C. Access doors shall be rated to maintain the fire/smoke rating of the wall/ceiling/construction in which they are installed.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulated flexible ducts.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For flexible ducts.
 - 1. Include plans showing locations and mounting and attachment details.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

- A. Products provided exclusively by one (1) of the following manufacturers:
 - 1. Buckley Associates
 - 2. Hart and Cooley
 - 3. Johns Manville

- B. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 210 deg F.
 - 4. Insulation R-Value: R6.

2.3 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches to suit duct size.
- B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- D. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.
- E. Install duct test holes where required for testing and balancing purposes.
- F. Installation:
 - 1. Install ducts fully extended.
 - 2. Do not bend ducts across sharp corners.
 - 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
 - 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
 - 5. Install flexible ducts in a direct line, without sags, twists, or turns.
- G. Supporting Flexible Ducts:
 - 1. Suspend flexible ducts with bands 1½ inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed ½-inch per 12 inches.
 - 2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
 - 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.

END OF SECTION 233346

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Modulating, single-duct air terminal units.
 - 2. Parallel fan-powered air terminal units.
 - 3. Casing liner.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For air terminal units.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal:
 - 1. Materials, fabrication, assembly, and spacing of hangers and supports.
 - 2. Include design calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Size and location of initial access modules for acoustic tile.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Instructions for resetting minimum and maximum air volumes.
 - b. Instructions for adjusting software set points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan-Powered-Unit Filters: Furnish two spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings, Trane, or approved as equivalent by one (1) of the following manufacturers:
 - 1. Price
 - 2. Titus
- B. Equipment must be purchased from a commercial sales office that offers full sales, technical support and has full-service operation with a minimum of (10) service trucks. The commercial sales office shall have access to electronic sales, service and technical software for complete submittal packages and after-market support.
- C. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- D. Casing: 22-gauge-thick galvanized steel, single wall.
 - 1. Casing Liner: Comply with requirements in the "Casing Liner" Article for duct liner.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections, size matching inlet size.

4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, two percent (2%) of nominal airflow at 3-inch wg inlet static pressure.
- F. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1-inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- G. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
1. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multi-point velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Occupied and unoccupied operating mode.
 - b. Remote reset of airflow or temperature set points.
 - c. Adjusting and monitoring with portable terminal.
 - d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 2. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.
- H. Controls:
1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
 2. System-powered, wall-mounted thermostat.
- I. Control Sequences:
1. Occupied:
 - a. In a call for cooling, airflow will increase as the damper opens towards maximum setting to satisfy set point.
 - b. In a call for less cooling, airflow will decrease as the damper closes towards minimum setting to satisfy set point.
 2. Unoccupied:
 - a. Damper closes to minimum maximum setting.
- 2.3 PARALLEL FAN-POWERED AIR TERMINAL UNITS
- A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings, Trane, or approved as equivalent by one (1) of the following manufacturers:
1. Price

2. Titus
-
- B. Description: Volume-damper assembly and centrifugal fan in parallel arrangement inside unit casing with control components inside a protective metal shroud.
 - C. Casing: Minimum 22-gauge- thick galvanized steel.
 1. Casing Liner: Comply with requirements in "Casing Liner" Article below for "Casing Liner, Fibrous Glass" Paragraph.
 2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
 3. Air Outlet: S-slip and drive connections.
 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
 5. Fan: Forward-curved centrifugal, located at plenum air inlet.
 - D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
 1. Maximum Damper Leakage: AHRI 880 rated, one percent (1%) of nominal airflow at 4-inch wg inlet static pressure.
 - E. Velocity Sensors: Multi-point array with velocity inlet sensors.
 - F. Fan Motor:
 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
 2. Type: Permanent-split capacitor with SCR for speed adjustment.
 3. Fan-Motor Assembly Isolation: Rubber isolators.
 4. Enclosure: Open drip proof.
 5. Enclosure Materials: Cast iron.
 6. Motor Bearings: Self Lubricating.
 7. Efficiency: Premium efficient as defined in NEMA MG-1.
 8. Motor Speed: Variable speed.
 - a. Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.
 9. Electrical Characteristics: Refer to Schedules on Drawings.
 - G. Filters:
 1. Pleated Glass Fiber: Factory-fabricated, self-supported disposable air filter with holding frames. Provide MERV 13 filter with minimum efficiency reporting value is to be in accordance with ASHRAE 52.2.
 - H. Attenuator Section: Casing material and thickness matching associated air terminal unit casing. Provide absorptive attenuator integral with the plenum inlet of the air terminal unit, of noise transmission loss performance as required in schedules on Drawings.
 - I. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1-inch. Include manual air vent and drain valve. Locate coil in plenum air inlet airstream. Provide hydronic heating coils for air terminal units scheduled on Drawings.
 - J. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
 2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs will match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized in accordance with NFPA 70.
 3. Disconnect Switch: Factory-mounted fuse type.
- K. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.
- L. Direct Digital Controls:
1. Terminal Unit Controller: Pressure-independent, VAV controller with integrated actuator and electronic airflow transducer with multi-point velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.
 - a. Occupied and unoccupied operating mode.
 - b. Remote reset of airflow or temperature set points.
 - c. Adjusting and monitoring with portable terminal.
 - d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 2. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.
 3. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controllers, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."
- M. Control Sequence: See Section 230993 "Sequence of Operation for HVAC" for control sequences.
- 2.4 CASING LINER
- A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Minimum Thickness: ½-inch.
 - a. Maximum Thermal Conductivity:
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Anti-microbial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Anti-microbial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 3. Solvent or Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- B. Casing Liner: Flexible elastomeric duct liner fabricated of pre-formed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Minimum Thickness: ½-inch.

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to AHRI 880.
 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." & ASCE/SEI 7. Comply with requirements for seismic-restraint devices in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on air terminal units that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service or an agency acceptable to authorities having jurisdiction.

- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed 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. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.3 TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

3.4 CONNECTIONS

- A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
- B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
- D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.5 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

3.8 DEMONSTRATION

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

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Ceiling Diffusers: Rectangular and square.
 - 2. Ceiling Linear Slot Outlets: Linear slot diffusers.
 - 3. Registers and Grilles:
 - a. Adjustable registers.
 - b. Fixed face grilles.
- B. Related Sections:
 - 1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Kruger
 - b. Price Industries
 - c. Titus
 - d. No substitutions.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Characteristics and Performance:
 - a. Refer to Schedules on Drawings.
 - b. Material: Aluminum.
 - c. Finish: Baked enamel, color to be selected by the Architect and Owner from manufacturer's entire range.
 - d. Face Size: See Schedule on Drawings.
 - e. Mounting: Surface and T-bar. See Schedule on Drawings and refer to Architectural RCP drawing.
 - f. Pattern: Adjustable.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Kruger
 - b. Price Industries
 - c. Titus
 - d. No substitutions.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Characteristics and Performance:
 - a. Material - Shell: Aluminum, insulated.
 - b. Material - Pattern Controller and Tees: Aluminum.
 - c. Finish - Face and Shell: Baked enamel, black.
 - d. Finish - Pattern Controller: Baked enamel, black.
 - e. Finish - Tees: Baked enamel, color selected by Architect and Owner from manufacturer's entire range.
 - f. Slot Width: See Schedule on Drawings.
 - g. Number of Slots: See Schedule on Drawings.
 - h. Accessories: See Schedule on Drawings.

2.3 REGISTERS AND GRILLES

A. Adjustable Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Kruger
 - b. Price Industries
 - c. Titus
 - d. No substitutions.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Characteristics and Performance:
 - a. Refer to Schedules on Drawings.
 - b. Material: Steel.
 - c. Finish: Baked enamel. Color to be selected by the Architect and Owner from manufacturer's entire range.
 - d. Face Blade Arrangement: Vertical spaced $\frac{3}{4}$ -inch apart.
 - e. Individually adjustable double deflection
 - f. Core Construction: Integral.
 - g. Rear-Blade Arrangement: Horizontal spaced $\frac{3}{4}$ -inch apart.
 - h. Frame: $1\frac{1}{4}$ inches wide.
 - i. Mounting: Countersunk screw.

B. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Kruger
 - b. Price Industries
 - c. Titus
 - d. No substitutions.
2. Characteristics and Performance:
 - a. Refer to Schedules on Drawings.
 - b. Material: Steel.
 - c. Finish: Baked enamel. Color to be selected by the Architect and Owner from manufacturer's entire range.
 - d. Face Blade Arrangement: Horizontal spaced $\frac{3}{4}$ -inch apart.
 - e. Blade Deflection Angle: 35 degrees.
 - f. Frame: $1\frac{1}{4}$ inches wide.
 - g. Mounting: Countersunk screw and Lay-in. See Schedule on Drawings.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Roof hoods.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.

- B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

- 1. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq. ft., acting inward or outward.

- C. Seismic Performance: Ventilators, including attachments to other construction, 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."

- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

- 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

- E. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. For louvered-penthouse ventilators specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

- B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.
- F. Delegated-Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of shop-fabricated ventilators.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Structural members to which roof curbs and ventilators will be attached.
 2. Sizes and locations of roof openings.
- B. Seismic Qualification Certificates: For ventilators, 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. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.2, "Structural Welding Code - Aluminum."
 2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.7 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653, G90 zinc coating, mill phosphatized.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.
- E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless-steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 - 1. Use types and sizes to suit unit installation conditions.
 - 2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
- F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to four (4) times the loads imposed for concrete, or six (6) times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

- A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

2.3 ROOF HOODS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - 1. Acme Engineering & Mfg. Corporation
 - 2. Greenheck Fan Corporation
 - 3. Loren Cook Company
 - 4. No substitutions.
- B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.
- C. Materials: Aluminum sheet, minimum 0.064-inch-thick base and 0.040-inch-thick hood; suitably reinforced.

- D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1½-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1½-inch wood nailer. Size as required to fit roof opening and ventilator base.
- E. Bird Screening: Aluminum, ½-inch-square mesh, 0.041-inch wire.
- F. Galvanized-Steel Sheet Finish:
 - 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
 - 2. Baked-Enamel Finish: Immediately after cleaning and pre-treating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Install gravity ventilators with clearances for service and maintenance.
- C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.
- E. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- F. Protect galvanized and non-ferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- G. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

END OF SECTION 233723

SECTION 234316 - DEDICATED CLEAN AIR SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dedicated Clean Air System modules.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated air-flow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1-2019 and 2022

C. Product Data: Manufacturer's technical product data for dedicated clean air systems.

1. Schedule of dedicated clean air systems indicating unit designation, number of each type required for application.
2. Data sheet for each system type, and accessories furnished including ionization units. Indicate construction, sizes, and mounting details.
3. Ion performance data for each type of ionization device furnished, presented in ions/cc, measured in still air, at chest height in the distribution zone.
4. Product drawings detailing physical, electrical and control requirements.

D. Shop Drawings: For dedicated clean air systems.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Show assembly, dimensions, materials, and methods of assembly of components.
3. Include setting drawings, templates, and requirements for installing anchor bolts and anchor-ages.
4. Diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Certificates, for filters, 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. Proof of compliance with UL 2998, "Environmental Claim Validation Procedure for Zero Ozone Emissions from Air Cleaners."

- a. Submit certificates that are listed on one of the following websites:

- 1) <https://spot.ul.com/>.
- 2) <https://sustainabilitydirectory.intertek.com/home>.

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.

B. Product Test Reports: For each air cleaner, for tests performed by a qualified testing agency.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit operation and maintenance data and recommended spare parts lists. Include 10 years of operations and energy costs

B. Warranty certificate.

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.Provide [one] <Insert number> complete set(s) of filters for clean air system.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

B. Manufacturer Qualifications: Company that specializes in manufacturing products specified in this Section.

1.ISO 9001-compliant manufacturing process.

2.ISO 9001: 2015-compliant administrative processes.

3.Documented Experience: 10 years, minimum.

4.Furnish services of manufacturer's qualified representative to inspect finished air ionization system.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean, dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
 2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
 3. Replace installed products damaged during construction.

1.8 WARRANTY

- A. Furnish equipment having manufacturer's warranty against defects in material and workmanship for a period of one year after date of shipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. GPS Air, smartIAQ
- B. Original Equipment Manufacturer (OEM) rebranded/private labelled equivalent.
- C. Approved equipment alternates (prior written approval or consent by Engineer of Record is required). Equipment Alternates must meet performance criteria detailed within this specification.

2.2 PERFORMANCE REQUIREMENTS

- A. ASHRAE 62.1 Compliance:
1. Comply with Indoor Air Quality performance requirements in ASHRAE 62.1-2022, by way of utilizing the Indoors Air Quality Procedure.
- B. ASHRAE 145.2 Compliance:
1. Evaluation of Dedicated Clean Air System removal efficacies of design compounds shall comply with ASHRAE 145.2 – 2011.
 2. Gas-phase cleaning efficiencies must meet the below detailed minimums for single pass air cleaning with regard to the following design compounds:

Design Compound	Design Target ($\mu\text{g}/\text{m}^3$)	Filter Removal Efficiency (minimum)
Acetaldehyde	140	53.1%
Acetone	1200	77.4%
Benzene	3	100%
Dichloromethane	400	63.8%
Formaldehyde	33	63.6%
Naphthalene	9	100%
Phenol	10	45.1%
Tetrachloroethylene	35	99.9%

Toluene	300	100%
1, 1, 1-trichloroethane	1000	65.2%
Xylene	500	100%
PM _{2.5} /Particulate Matter	12	MERV 14
Carbon Monoxide	10310	1.4%
Ozone	137	100%
Ammonia	200	22.6%

C. Comply with the following:

- 1.ASHRAE 62.1 – 2019 & 2022
- 2.ASHRAE 241 – 2023 Appendix A (3rd party Safety testing)
- 3.ASHRAE 145.2 - 2016
- 4.UL 900
- 5.UL 867.
- 6.UL 2998.
- 7.FCC Part 18.
- 8.NFPA 70
- 9.NFPA 90A
10. NFPA 90B

D. Substitutions: No substitutions.

2.3 CAPACITIES AND CHARACTERISTICS

A. Provide a Dedicated Clean Air System at locations indicated on Drawings.

B. Humidity: Provide systems:

- 1.That do not require preheat protection when relative humidity of entering air exceeds 85 percent.
- 2.That are suitable for relative humidity from 20 to 90 percent, condensing, without causing damage, deterioration, or dangerous conditions within system.

C. Provide integrated filters:

- 1.MERV 14 Particulate Filter that meets ASHRAE 52.2
- 2.Molecular Filter that meets ASHRAE 145.2

D. Provide Integrated Ionization:

- 1.Ionization Output: Provide systems that produce positive and negative ions. Unipolar ionization devices are unacceptable.
- 2.Ionization Device Enclosures: Provide corrosion-resistant, non-metallic materials. Configure enclosure without thermal bridging.
- 3.Mount securely inside enclosure.

E. Maximum Ozone Emissions: In accordance with limits stated in UL 2998.

- 1.Products not certified in accordance with UL 2998 are unacceptable.
- 2.Provide products listed on UL SPOT or Intertek Sustainability product database(s) as UL 2998-compliant. Products not listed in either database are unacceptable. Submit manufacturer's test report showing compliance with UL 2998.

F. Design Requirements:

- 1.Product must operate independent of HVAC system or other ventilation airflow.
- 2.Product must be capable of mounting either suspended above a drop ceiling
- 3.Provide ionization units having manufacturer's recommended number of electrodes and power generators, sized to system air flow.
- 4.NPBI Electrodes:
 - a. Materials: Carbon fiber clusters having minimum 45000 needles each.
 - 1) Metal electrodes are unacceptable.
 - 2) Bipolar ionization tubes manufactured of glass, composite, mica, or similar dielectric materials are unacceptable.

G. Control Requirements:

- 1.NPBI Devices:
 - a. Internal short-circuit protection.
 - b. Overload protection.
 - c. Automatic fault reset circuit breakers. Units having fuses are unacceptable.
- 2.Ionization Output: Provide unit that varies ion output in proportion to airflow velocity.

2.4 IONIZING FILTER FAN MODULES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide GPS Air; Model: smartIAQ Dedicated Clean Air System or comparable product.
- B. Source Limitations: Obtain from single source from single manufacturer.
- C. Description: Factory-fabricated, air cleaning filter system with ionization device.
- D. DCAS Capacity and Characteristics:
 - 1.Capacity: 0 to 500 cfm.
 - 2.Temperature Range: 32 to plus 104 deg F (0 to plus 40 deg C).
 - 3.Relative Humidity Range: 5 to 85 percent (non-condensing).
 - 4.Unit Dimensions (23 x 26 x 14) inches.
 - 5.Fan Unit Weight: [70] lb ([31.8] kg).
 - 6.Weight with optional transformer [78] lb ([35.5] kg).
 - 7.Unit Sound Level: [50] dB(A) Maximum (measured at 2 ft)
 - 8.Noise Criterion Level (NC): 34 Maximum
- E. Electrical Characteristics:
 - 1.Electrical Listings: UL, cUL.
 - 2.Compliance and Certifications: CARB, FCC Part 18, UL 507, UL 867, and UL 2998.
 - 3.Standard Input Voltage: 120 V ac, 60 Hz.
 - 4.Optional Input Voltage (Transformer accessory required): 208/230/288/347 V ac, 60Hz
 - 5.Power Consumption: [200] W (Max).
 - 6.Total Ion Output at emitters: Minimum 160 million ions/cc, measured 1 inch (25 mm) from carbon fiber brushes.

F. Control Characteristics:

1.DETAIL CONTROL STRATEGY

- a. System should employ internal solid state sensor(s) to continuously monitor the following:
 - 1) Carbon Dioxide (CO₂)
 - 2) Formaldehyde (HCHO)
 - 3) TVOC
 - 4) PM_{1.0}, PM_{2.5}, PM_{4.0}, PM_{10.0}
 - 5) Temperature
 - 6) Humidity
- b. System should operate at a minimum airflow while monitoring the environment.
- c. System should be able to increase airflow when triggering levels of sensed design compounds are reached.
- d. System should clean environment through use of particulate and molecular filtration.

When levels of sensed design compounds are reduced below set level, system should return to minimal monitoring air flow.

G. Casing:

- 1.Configuration: Ducted inlet
- 2.Module Material: Minimum 18-gauge carbon steel with mill finish.

H. Filters:

1.Particulate Filter:

- a. Filter Performance Rating: MERV 14
- b. Face Size: 24 by 12 inches.
- c. Filter Depth: 2 inches nominal.
- d. Maximum or Rated Face Velocity: 500 fpm.
- e. Initial Resistance: 0.12 inches wg.
- f. Recommended Final Resistance: 1.5 inches wg.
- g. System Airflow: 500 cfm (Max)

2.Molecular Filter:

- a. Filter Performance Rating: standard VOC
- b. Filter construction: Impregnated Granular Activated Charcoal
- c. Minimum average removal efficiency (15 Design Compounds)
- d. Face Size: 24 by 12 inches.
- e. Filter Depth: 4 inches nominal.
- f. Maximum or Rated Face Velocity: 500 fpm.
- g. Initial Resistance: 0.12 inches wg.
- h. System Airflow: 500 cfm (Max)

3.Filter Access: Side.

I. Integrated Ionization:

- 1.Materials: Carbon fiber ion emitters.
- 2.Capacity: 0 to 500 cfm.
- 3.Temperature Range: 32 to plus 104 deg F (0 to plus 40 deg C).
- 4.Relative Humidity Range: 5 to 85 percent (non-condensing).

5. Unit Dimensions (Dia x H): 3.6 x 2.1 inches (91 x 53 mm).

6. Unit Weight: 2.0 lb (0.9 kg).

J. Accessories: Filter test port.

K. Motor:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

2. Type: Permanent-split capacitor with SCR for speed adjustment.

3. Fan-Motor Assembly Isolation: Rubber isolators.

4. Electrical Characteristics:

a. Refer to Drawing Schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine dedicated clean air systems, and conditions for compliance with requirements for 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. Position each air cleaning system unit with clearance for normal service and maintenance. Anchor unit holding frames to substrate.

B. Install units in accordance with manufacturer's written instructions.

C. Install filters in position to prevent passage of unfiltered air.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace any temporary filters that were used during construction and testing with new, clean filters.

3.3 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Coordinate field inspection in accordance with "Quality Assurance" Article in this Section and in appropriate Sections in Division 01.

1. Manufacturer's Inspection and Training Services: Furnish services of manufacturer authorized representative to verify correct installation and perform training of Owner's staff.

3.5 STARTUP, COMMISSIONING, AND TRAINING

- A. Manufacturer's Startup Services: Provide startup supervision and training of Owner's personnel in the proper operation and maintenance of equipment.
- B. Commissioning Agent: Use Alpha Labs Air Ion Counter's Model "AIC2" or "AIC3-Pro" and confirm, on installed units, that ion output meets value listed on product data sheet when both polarities are measured and added together.
 - 1.Measurement: At chest height in the ion distribution area.
 - 2.For Each Installation: Randomly select and test minimum 10 percent of installed units to confirm compliance and Submit test report.
- C. Training: Train Owner's personnel on use and replacement of NPBI air ionization system or NPBI components.

END OF SECTION 234316

SECTION 237200 - AIR-TO-AIR ENERGY RECOVERY VENTILATOR

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 Air-to-Air Energy Recovery Ventilators for rooftop installation.
- B. Within this document, these units may be referred to as Energy Recovery Ventilator (ERV) for brevity.
- C. Related Sections:
 - 1. Section 230923 "Direct Digital Controls (DDC) System for HVAC".

1.3 SUBMITTALS

- A. Product data: For each type or model of Energy Recovery Ventilator, include the following:
 - 1. Unit performance data for both Supply Air and Exhaust Air, with system operating conditions indicated.
 - 2. Enthalpy plate performance data for both summer and winter operation.
 - 3. Motor ratings and unit electrical characteristics.
 - 4. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
 - 5. Estimated gross weight of each installed unit.
 - 6. Filter types, quantities, and sizes
 - 7. Installation, Operating and Maintenance manual (IOM) for each model.
- B. Shop Drawings: For air-to-air energy recovery ventilators, include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and maintenance data for air-to-air energy recovery ventilator

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain Air-to-Air Energy Recovery Ventilator with all appurtenant components or accessories from a single manufacturer.
- B. For the actual fabrication, installation, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.

- C. The ERV core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten (10) years from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two (2) years from the date of installation.
- D. Manufacturer shall be able to provide evidence of independent testing of the core by Underwriters Laboratory (UL), verifying a maximum flame spread index (FSI) of 25 and a maximum smoke developed index (SDI) of 50 thereby meeting NFPA90A and NFPA 90B requirements for materials in a compartment handling air intended for circulation through a duct system. The method of test shall be UL Standard 723.
- E. Certifications:
 - 1. The energy recovery cores used in these products shall be third party Certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. AHRI published certifications shall confirm manufacturer's published performance for airflow, static pressure, temperature and total effectiveness, purge air (OACF) and exhaust air leakage (EATR). Products that are not currently AHRI certified will not be accepted. OACF shall be no more than 1.02 and EATR shall be zero when application design criteria reduce static pressure differential to zero or less.
 - 2. Entire unit shall be listed under UL 1812 Standard for Ducted Air to Air Heat Exchangers and comply with CSA Standard 22.2.
 - 3. Units intended for outdoor use shall be rain tested in accordance with UL 1812 Section 67.
- F. Every unit to be factory tested prior to shipping: Motor Dielectric Voltage-Withstand Bench Test, Unit Dielectric Voltage-Withstand Test, Continuity of Internal Control Circuits Test, Unit Amperage Test
- G. Manufacturer should be in business for minimum ten (10) years manufacturing energy recovery ventilators.

1.5 COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each Energy Recovery Ventilator and associated electrical systems.
- B. Coordinate sequencing of construction for associated plumbing, HVAC, electrical supply.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
 - 1. Greenheck
 - 2. RenewAire
 - 3. Ruskin

2.2 MANUFACTURED UNITS

- A. Air-to-Air Energy Recovery Ventilators shall be fully assembled at the factory and consist of a fixed-plate cross-flow heat exchanger with no moving parts, an insulated single wall painted 20-gauge steel cabinet, outdoor air hood with bird screen, motorized outside air intake damper, filter assemblies for both intake and exhaust air, enthalpy core, supply air blower assembly, motorized return air damper, exhaust air hood, exhaust air blower assembly and electrical control box with all specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection. Entire unit with the exception of field-installed components shall be assembled and test operated at the factory.

2.3 CABINET

- A. Materials: Formed single wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
- B. Outside Casing: 20-gauge, galvanized (G90) steel meeting ASTM A 653 for components that do not receive a painted finish. Painted components as supplied by the factory shall have polyester urethane paint on 20-gauge G90 galvanized steel. The unit shall be painted on five (5) sides, base unpainted.
- C. Access doors shall be hinged with airtight closed cell foam gaskets. Door pressure taps, with captive plugs, shall be provided for cross-core pressure measurement allowing for accurate airflow measurement.
- D. Cabinet Insulation: Case walls and doors shall be fully insulated with 1-inch, expanded polystyrene foam insulation faced with a cleanable foil face on all exposed surfaces.
- E. Enthalpy Core: Energy recovery core shall be of the total enthalpy type, capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air. No condensate drains shall be allowed. The energy recovery core shall be designed and constructed to permit cleaning and removal for servicing. The energy recovery core shall have a ten-year warranty. Performance criteria are to be as specified in AHRI Standard 1060.
- F. Control Center/Connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections to the non-fused disconnect.
- G. Passive Frost Control: The ERV core shall perform without condensing or frosting under normal operating conditions (defined as outside temperatures above -10 F and inside relative humidity below forty percent (40%)). Occasional more extreme conditions shall not affect the usual function, performance or durability of the core. No condensate drains will be allowed.
- H. Motorized Isolation Dampers: Return and outside air motorized dampers of an AMCA Class I low leakage type shall be factory installed.

2.4 BLOWER SECTION

- A. Blower Section Construction, Supply Air, and Exhaust Air: Blower assemblies consist of a 208-230V/1 Phase/60 HZ, ECM motor, and a direct driven backward-curved blower.
- B. Blower Assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

2.5 MOTORS

- A. Blower motors shall be electronically commutated (EC) motorized impellers with multi-speed capability.
- B. The impeller type shall be backward-curved.

2.6 UNIT CONTROLS

- A. Fan Control: Terminal strip for EC motors.
- B. Sensors: None.
- C. Timeclock: Digital Time Clock wall mount with up to eight (8) on/off cycles per day or fifty (50) per week, 24VAC power, with battery backup protection of program settings against power failure to energize unit.
- D. Motion (Occupancy) Sensor: Passive infrared sensor for wall mounting with adjustable time-off delay to 30 minutes, 24VAC power to energize unit.
- E. Carbon Dioxide: Adjustable control from 600-2000 PPM for wall mounting with digital display.

2.7 FILTER SECTION

- A. ERV shall have 2-inch-thick MERV 13 disposable pleated filters located in the outdoor air and exhaust airstreams. All filters shall be accessible from the exterior of the unit.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
- B. Examine roughing-in of plumbing, electrical, and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
- C. Proceed with installation only after all unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices, and all applicable building codes.
- B. Install unit with clearances for service and maintenance.

3.3 CONNECTIONS

- A. ERV's are to be installed per manufacturers' guidelines and industry Best Practices shall be incorporated. Duct connections are to conform to use material, weight, thickness, gauge, construction, and installation methods as outlined in the SMACNA publications below, and

Division 23 of this document, and are to be made subject to the installation requirements shown above.

1. HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005
2. HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012
3. HVAC Systems - Duct Design, 4th Edition, 2006
4. Rectangular Industrial Duct Construction Standard, 2nd Edition, 2004
5. Round Industrial Duct Construction Standards, 2nd Edition, 1999
6. Thermoplastic Duct (PVC) Construction Manual, 2nd Edition, 1995
7. Electrical installation requirements are specified in Division 26 of this document.

3.4 FIELD QUALITY CONTROL

- A. Contractor to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to Architect/Engineer in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM. Insert any other requirements here.

3.5 START-UP SERVICE

- A. Contractor to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage. Refer to Section 230593 "Testing, Adjusting and Balancing" and comply with provisions therein.

3.6 DEMONSTRATION AND TRAINING

- A. Contractor to train Owner's maintenance personnel to adjust, operate, and maintain the entire Make-Up Air unit. Refer to Sections 017700 "Closeout Procedures" and 017839 "Demonstration and Training".

END OF SECTION 237200

SECTION 237416 - PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes packaged, 3-to-25-ton, rooftop air-conditioning units (RTUs) with the following components and accessories:
 - 1. Package roof top unit.
 - 2. Casings.
 - 3. Fans.
 - 4. Motors.
 - 5. Coils.
 - 6. Refrigeration components
 - 7. Refrigerant circuit components.
 - 8. Air filtration.
 - 9. Electric heater.
 - 10. Dampers.
 - 11. Electrical power connections.
 - 12. Unit operating controls.
 - 13. Controls.
 - 14. Accessories.
 - 15. Roof curbs.
 - 16. Operation and maintenance service.

1.3 DEFINITIONS

- A. DDC: Direct digital controls.
- B. ECM: Electronically commutated motor.
- C. MERV: Minimum efficiency reporting value.
- D. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, small-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating

operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 REFERENCES

- A. NFPA 90 A & B.
- B. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- C. AHRI 340/360- 2015 - Commercial and Industrial Unitary Air Conditioning Equipment testing and rating standard. (g/e, c/e above 135,000 btuh)
- D. ANSI/ASHRAE 37 - Testing Unitary Air Conditioning and Heat Pump Equipment.
- E. ANSI/ASHRAE/IESNA 90.1-1999 - Energy Standard for New Buildings Except Low-Rise Residential Buildings.
- F. ANSI Z21.47/UL1995 - Unitary Air Conditioning Standard for safety requirements and testing requirements for commercial warm air furnaces.
- G. California Energy Commission Administrative Code - Title 20/24
- H. AHRI 210/240 - Unitary Air-Conditioning Equipment and Air-Source Heat Pump Equipment.
- I. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.
- J. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air Conditioning Equipment (all above 135,000 Btuh)

1.5 ACTION SUBMITTALS

- A. Product Data: For each RTU.
 - 1. Include manufacturer's technical data.
 - 2. Include rated capacities, operating performance, dimensions, required clearances, characteristics, and furnished specialties and accessories.
 - 3. Include mechanical specifications for unit and accessories describing construction, components, and options.
- B. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Submit shop drawings indicating overall dimensions as well as installation, operation, and services clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.
 - 4. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.
 - 5. Shop drawings submitted for approval shall be accompanied by a copy of the purchase agreement between the Contractor and an authorized service representative of the manufacturer for check, test and start up and first year service.

- C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - 3. Wind- and Seismic-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which RTUs will be attached.
 - 2. Roof openings.
 - 3. Roof curbs and flashing.
- B. Seismic Qualification Data: Certificates, for RTUs, 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.
 - 4. Restraint of internal components, including fans, coils, and refrigeration components.
- C. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force 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.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

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. Fan Belts: Two (2) sets for each belt-driven fan.
 - 2. Filters: Two (2) sets of filters for each unit.

1.9 DELIVERY, STORAGE, and HANDLING

- A. Comply with manufacturer's installations instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of RTUs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Parts: Manufacturer's standard, but not less than one (1) year from start-up or eighteen (18) months from shipment.
 - 2. Warranty Period for Compressors: Manufacturer's standard, but not less than five (5) years from date of Substantial Completion.

1.11 MAINTENANCE SERVICE

- A. All work on units shall be accomplished by OEM factory trained and authorized service technicians.

1.12 REGULATORY REQUIREMENTS

- A. Units are cULus listed and labeled.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. AHRI Compliance:
 - 1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
 - 3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
 - 4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.
- B. AMCA Compliance:
 - 1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
 - 2. Damper leakage tested according to AMCA 500-D.
 - 3. Operating Limits: Classify according to AMCA 99.
- C. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES Compliance: Comply with applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. NFPA Compliance: Comply with NFPA 90A or NFPA 90B.
- F. UL Compliance: Comply with UL 1995.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Trane or comparable product by one (1) of the following:
1. Lennox
 2. Carrier
 3. No substitutions.
- B. Equipment must be purchased from a commercial sales office that offers full sales, technical support and has full-service operation with a minimum of ten (10) service trucks. The commercial sales office shall have access to electronic sales, service, and technical software for complete submittal packages and after-market support.

2.3 GENERAL UNIT DESCRIPTION

- A. Packaged rooftop units cooling, heating capacities, and efficiencies are AHRI Certified within scope of AHRI Standard 210-240 for 6 to 25 Tons and ANSI Z21.47.
- B. Rooftop unit shall be factory assembled, internally wired, fully charged with R-454B, and one hundred percent (100%) run tested to check cooling operation, fan and blower rotation, and control sequence before leaving the factory.
- C. All units, 3-25T, shall have field convertible airflow.
- D. Internal wiring must be colored and numbered for simplified identification.
- E. Symbio controls operating range shall be between 0°F and 125°F in cooling mode.

2.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
1. Design RTU supports to comply with wind and seismic performance requirements.
- B. Wind-Restraint Performance:

1. Minimum 10 lb/sq. ft. multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

C. Seismic Performance: RTUs, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.5 AIR FILTRATION

A. Minimum arrestance and MERV according to ASHRAE 52.2.

2.6 UNIT CASING

A. Cabinet: Galvanized steel with baked enamel finish.

B. Rooftop unit casing shall be zinc coated, heavy gauge, steel. Casing panels are weather resistant pre-painted metal with galvanized substrate and meet ASTM B 117, 672-hour salt spray test.

C. Cabinet top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.

D. Unit shall include a removable single side maintenance access panels. Lifting handles in maintenance access panels can be removed and reinstalled by removing fasteners while providing a water and air tight seal.

E. Unit's base pan shall have a raised 1 1/8-inch-high lip around the supply and return openings for water integrity.

F. Exposed vertical panels and top covers in the indoor air section are insulated with a cleanable foil-faced, fire-retardant permanent, odorless glass fiber material.

G. Base pan shall have no penetrations within the perimeter of the curb other than the raised 1-inch-high downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up.

H. Base of the unit is insulated with 1/8-inch, foil-faced, closed-cell insulation.

I. Provide openings either on side of unit or through the base for power, control and condensate connections.

J. Unit base shall contain provisions for forklift and/or crane lifting on three (3) sides of unit.

2.7 AIR FILTERS

A. Refer to Schedules on Drawings.

2.8 FANS AND MOTORS

A. Supply fan shall be a direct drive plenum fan with backward-curved fan wheel with an external rotor direct drive variable speed motor.

- B. Supply fan speed adjustments can be made using the control user interface or mobile app.
- C. Provide Fan Fail indication. The indication will be registered at the on-board user interface, mobile service app., or building management system.
- D. Variable speed direct drive motors are premium efficiency – 6 to 25 tons.
- E. Motors are thermally protected.
- F. Outdoor fans shall be direct drive, statically and dynamically balanced, draw through in the vertical discharge position. Outdoor motors shall be 3 phase.
- G. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

2.9 FIN AND TUBE COILS (HEAT PUMP)

- A. Heat pump units shall have internally finned, 5/16-inch copper tubes, mechanically bonded to a configured aluminum plate fin.
- B. Assembled coil shall be factory leak tested to 600 psi.
- C. Assembled unit shall be leak tested to 465 psi.
- D. Provide a removable, reversible, cleanable double sloped drain pan for base of evaporator coil constructed of PVC.
- E. Unit shall include a condensate overflow switch to shut the unit down in the event that a clogged condensate drain line prevents proper condensate removal from the unit.

2.10 CONDENSER SECTION

- A. Provide vertical discharge, direct drive fans with aluminum blades. Fans shall be statically balanced. Motors shall be permanently lubricated, with integral thermal overload protection in a weather tight casing.
- B. Cooling only and electric heat condensers shall be microchannel.
- C. Heat pump condensers shall be 5/16-inch copper tubes mechanically bonded to a configured aluminum plate fin.
- D. Provide tool-less factory installed corrosion resistant louvered hail/vandalism guards to protect condenser coils from hail or physical damage.

2.11 REFRIGERATION SYSTEM

- A. All units have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps. Suction gas-cooled motor with voltage utilization range of plus or minus ten percent (+/-10%) of unit nameplate voltage. Internal overloads standard with scroll compressors. Crankcase heaters are standard on all compressors.
- B. Compressors shall have thermostatic temperature motor winding control for protection against excessive temperatures caused by over/under voltage operation or loss of charge. Also provide high- and low-pressure switches.

- C. Thermal expansion valves are standard for all models.
- D. All units have dual compressors.
- E. Units shall have cooling capabilities down to 0 degree F as standard. For field-installed low ambient accessory, the manufacturer shall provide a factory-authorized service technician that will assure proper installation and operation.
- F. For heat pump units, provide reversing valve, discharge muffler, flow control check valve, and electronic temperature initiated demand defrost.
- G. Three (3) stages of cooling available on 6 to 17.5 tons units and four stages of cooling available on 20 and 25 ton units.

2.12 LEAK DETECTION SENSORS

- A. Unit shall be furnished with a leak detection system from the factory when a circuit refrigerant charge exceeds 3.91 lbs. The leak detection system shall consist of one (1) or more refrigerant detection sensors. When the system detects a leak, the unit controller shall initiate mitigation actions.

2.13 EXHAUST/RETURN SECTION

- A. Provide barometric relief gravity type dampers to operate in conjunction with economizer to provide exhaust
- B. Provide, a factory supplied field installed power exhaust assembly that shall assist the barometric relief damper in the economizer in relieving building pressurization.

2.14 OUTDOOR AIR SECTION

- A. Motorized outside air damper, once set, when indoor fan starts, outdoor air dampers shall open to set position. When indoor fan shuts down, damper shall close to the full closed position.
- B. Provide spring return motor for outside air damper closure during unit shut down or power interruption.
- C. Provide microprocessor unit-mounted control which when used with an electronic zone sensor provides proportional integral room control. This UCM shall perform all unit functions by making all heating, cooling and ventilating decisions through resident software logic.
- D. Provide factory-installed indoor evaporator defrost control to prevent compressor slugging by interrupting compressor operation.
- E. Provide an anti-cycle timing and minimum on/off between stages timing in the microprocessor.

2.15 ELECTRIC HEATER

- A. Electric heaters shall be nickel chromium elements and will be delta connected for 240V and wye connected for 480V and 600V.
- B. Heater staging is commanded by the unit microprocessor control.
- C. Heater shall include at least one (1) automatic reset high temperature device and a single-operation high temperature limit control.

- D. Heaters shall be individually fused from the factory and shall be wired such that the unit's electrical connection is a single-point connection.

2.16 DAMPERS

- A. Leakage Rate: Comply with ASHRAE/IES 90.1.
- B. Damper Motor: Modulating with adjustable minimum position.

2.17 ELECTRICAL POWER CONNECTIONS

- A. RTU shall have a single connection of power to unit with unit-mounted weatherproof NEMA 3R disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.18 CONTROLS

- A. Unit shall be completely factory-wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Unit shall provide an external location for mounting a fused disconnect device. The resident control algorithms shall make all heating, cooling, and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor air conditions. The control algorithm maintains accurate temperature control, minimizes drift from set point, and provides better building comfort. Controls shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.
- B. BACnet Communication: The BACnet communications interface allows the unit to communicate directly with a generic open protocol BACnet MS/TP Network Building Automation System Controls.
- C. Connection to Building Management System to be furnished by rooftop unit manufacturer. Through this interface, all Building Management functions (within Section 230923 "Direct Digital Control (DDC) System for HVAC) shall be performed. See Building Automation and Automatic Temperature Control System Specifications. The only field connection to Building Management System shall be a single communication link.
- D. Control Functions: Include unit scheduling, occupied/unoccupied mode, start-up and coast-down modes, nighttime free-cool purge mode, demand limiting, night setback, discharge air set point adjustment, timed override, and alarm shutdown.
- E. Where Single Zone VAV RTU: Provide all necessary controls to operate a rooftop unit based on maintaining two (2) temperature setpoints: discharge air and zone. During one (1) zone vav cooling, the unit will maintain zone cooling setpoint by modulating the supply fan speed more or less to meet zone load demand; and the unit will maintain discharge temperature to the discharge cooling setpoint by modulating economizer if available and staging dx cooling.
- F. Where Multi-Zone VAV RTU: Provide all necessary controls to operate a vav rooftop from supply air temperature including microprocessor controller and supply air sensor. The microprocessor shall coordinate the economizer control and stages of cooling with supply air temperature reset capability based upon temperature.
- G. Clogged Filter Indication: Provide factory installed differential pressure switch to indicate filter replacement status. Differential pressure switch shall cause a contact closure to display a service indication and unit will continue to operate normally.

- H. Refer to sequence of operation within Section 230923 "Direct Digital Control (DDC) System for HVAC."
- I. Interface Requirements for HVAC Instrumentation and Control System:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
 - 3. Provide BACnet compatible interface for central HVAC control workstation for the following:
 - a. Adjusting set points.
 - b. Adjusting schedules.
 - c. Monitoring fan start, stop, and operation.
 - d. Inquiring data to include damper positions, supply- and room-air temperature, and humidity.
 - e. Monitoring temperatures throughout RTU sections: such as return, mixing, condenser discharge, supply, etc.
 - f. Monitoring discharge humidity.
 - g. Monitoring compressor operation.
 - h. Monitoring occupied and unoccupied operations.
 - i. Monitoring constant and variable motor loads.
 - j. Monitoring variable-frequency drive/speed control operation.
 - k. Monitoring cooling load.
 - l. Monitoring economizer cycles.
 - m. Monitoring air-distribution static pressure and ventilation air volume.
 - n. Monitoring alarms.
 - o. Monitoring air filter status.

2.19 ACCESSORIES

- A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.
- B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- C. Low-ambient kit using variable-speed condenser fans for operation down to -0 deg F.
- D. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- E. Remote potentiometer to adjust minimum economizer damper position.
- F. Return-air bypass damper.
- G. Factory- or field-installed, demand-controlled ventilation.
- H. Safeties:
 - 1. Smoke detector.
 - 2. Condensate overflow switch.
 - 3. Phase-loss reversal protection.
 - 4. High- and low-pressure control.

- I. Coil guards of painted, galvanized-steel wire.
- J. Hail guards of galvanized steel, painted to match casing.
- K. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.
- L. Door switches to disable heating or reset set point when open.
- M. Outdoor-air intake weather hood with moisture eliminator.
- N. Oil separator.
- O. Service Lights and Switch: Factory installed in each accessible section with weatherproof cover. Factory wire lights to a single-point field connection.
- P. Refer to Schedules on Drawings for any additional information and requirements.

2.20 ROOF CURBS

- A. The designated contractor shall supply and install a **Vibro-Curb III**, factory-fabricated combination roof mounting and vibration isolation base as manufactured by Thybar Corporation. Base shall be designed so that it can be re-roofed without disturbing the rooftop unit. Base flange attachments shall be provided for securing equipment mounting supports to the building structure. Base shall be fully welded and have mitered corners. Acoustically non-conductive material shall be provided to minimize sound transitions. The vibration isolation portion of the assembly shall be constructed of structural steel (depending on curb size) and designed to match perfectly with the bottom of the rooftop unit. The spring isolation shall be designed to provide a minimum of ninety percent (90%) isolation efficiency with 3-inch deflection. The roof curb shall be supplied complete with a wood nailing strip and continuous 9-inch rubber counter flashing making the **Vibro-Curb III** watertight.
- B. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.
- C. Materials: G-90 14-gauge galvanized steel with corrosion-protection coating, fully welded and mitered corners, base flange attachments for securing equipment mounting supports to the building structure, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1136, Type II.
 - b. Thickness: 2 inches.
 - c. UL 181 Class 1.
 - d. Service Temperature: 250F.
 - e. Surface Burning Characteristics:
 - 1) UL Listed.
 - 2) Does not exceed 25 Flame Spread, 50 Smoke Developed when tested in accordance with ASTM E84, NFPA 255, and UL 723.
 - 3) Water Vapor Transmission Rate (ASTM E 96): Less than 0.02 perms.

- 4) Water Vapor Sorption (ASTM C 1104): Less than five percent (5%) by weight.
 - 5) Microbial Growth (ASTM G 21, UL 181): Does not promote or support growth of fungi or bacteria.
 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
 - D. Curb Dimensions: Height of 16 inches.
- 2.21 ENERGY RECOVERY WHEELS
- A. Basis-of-Design Product: Subject to compliance with requirements, provide SEMCO or comparable product by one (1) of the following:
 1. Greenheck Fan Corporation
 2. Loren Cook Company
 3. Ruskin Rooftop Systems
 - B. Source Limitations: Obtain packaged, outdoor, heat-wheel, energy-recovery units from single manufacturer.
 - C. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1.
 - D. Capacities and Characteristics: Refer to Schedules on Drawings.
 - E. Total Energy Recovery Wheel:
 1. The rotor media will be made of aluminum which is coated to prohibit corrosion. All surfaces will be coated with a non-migrating adsorbent specifically developed to maximize latent recovery. Equal sensible and latent recovery efficiencies will be clearly documented through a certification program conducted in accordance with ASHRAE 84-78P and ARI 1060 standards. The media will be cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery. Dry particles up to 600 microns will freely pass through the media. Wheel media will be independently tested and shown to conform with the requirements of NFPA-90A, documenting a flame spread of less than 25 and a smoke generation rating of less than 50.
 2. Rotor Cassette: The rotor cassette will be a sheet metal framework which limits the deflection of the rotor due to air pressure. The cassette will be made of galvanized steel to prevent corrosion. The rotor cassette will be easily removable from the Energy Recovery Unit to facilitate rigging (if necessary) and ease of service. The wheel cassette design will use pillow block bearings for long life. A non-adjustable purge sector will be included in the cassette.

- F. Casing: Panels will be 20-gauge galvanized steel, lined with ½-inch-thick neoprene insulation where required. The housing will be supported by a formed structural base that forms a pan to ensure weather tight construction. Lifting holes will be provided at the unit base. Units will have a weatherproof sheet metal roof. The outdoor air intake opening will be protected by a galvanized steel sheet metal weather hood (except for indoor construction) and include an automatic shutoff damper with electric operator. The exhaust air discharge will be covered with a gravity backdraft damper and weather hood (except for indoor construction).
- G. Supply and Exhaust Fans: Centrifugal, forward-curved fan with spring isolators of 1-inch static deflection.
 - 1. Motor and Drive: Direct driven, with speed changed by variable-frequency motor controller.
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Motor Sizes: Minimum size as indicated. If size is not indicated, provide motor large enough so driven load will not require motor to operate in service factor range above 1.0.
- H. Access: Access to components will be provided through a large, hinged, tightly sealed and easily removable access door. Access doors will be constructed of the same materials as the unit casing and use SEMCO's standard hardware. The wheel cassette will be easily removable from the unit. The roof of the unit will also be removable for access.
- I. Unit Configuration: The supply air inlet and exhaust air outlet must be oriented at opposite ends of the Energy Recovery System to maximize the distance between the two (2) airstreams in order to minimize the risk of short-circuiting exhaust air into the supply air intake.
- J. Electrical Panels: Units will require a single point 60-cycle power connection at the voltage and phase listed within this submittal. The electrical panel will consist of individual motor contactors, short circuit and overload protection, and control power transformer. The electrical panel will be mounted interior to the unit behind the access door. Unit will be ETL listed and labeled. An integral start/stop relay is provided to link the SP unit operation with the RTU.
- K. Filters:
 - 1. The outdoor air filters will be 2-inch-thick replaceable MERV 13 filters, listed as Class 2 in accordance with UL 900.
 - 2. The return air filters will be 2-inch-thick replaceable MERV 8 filters, listed as Class 2 in accordance with UL 900.
- L. Recovery Wheel Control: During economizer operation the controller will initiate a stop/jog function to maintain the self-cleaning feature of the wheel. Otherwise, the wheel is operated at full speed for maximum recovery.
- M. Rotation Detector, Filter Monitoring, Indicating Display: Includes a BACview-5 two (2) row backlit LCD display to allow setpoints to be adjusted and status points to be viewed. Controller supports remote communications using BACnet over MS/TP, Modbus, or N2 protocols. Pressure switches are provided across the outdoor and return air filters, wired to inputs on the controller. Rotation detector with indicating light is provided to indicate wheel rotation failure or filter loading alarm.

- N. Integrated Economizer Collar with Full Controls: Integral economizer section designed to optimize overall system fan efficiency as called for by ASHRAE 90.1 2013. Economizer section includes ultra-low leakage damper (leakage less than 3 cfm/sqft) as required by ASHRAE 90.1. Economizer includes fully wired damper operator(s) and sensors feeding the on-board DDC control module with full communications capability. Advanced control logic including both comparative enthalpy (outdoor vs return air values) and supply air absolute humidity limits based on space humidity levels. Control logic locks out of all cooling stages unless loads cannot be met with economizer alone.
- O. Pedestal Support: Pedestal Support - SP unit will be supplied with an adjustable pedestal to support the SP unit from the roof structure or floor. This relieves stress from the Precedent units back panel.
- P. Power Exhaust: SP exhaust quantity used during recovery mode also used for power exhaust.
- Q. Disconnect: Unit shall be provided with a non-fused safety disconnect switch sized to provide a suitable disconnecting means for the unit. The disconnect is to be shipped loose for field installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Contractor shall verify that roof is ready to receive work and opening dimensions are correct.
- F. Contractor shall verify that proper power supply is available.

3.2 INSTALLATION

- A. Contractor shall install in accordance with manufacturer's instructions.
- B. Mount units on factory-built roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.
- C. Roof Curb: Install on roof structure, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- D. Equipment Mounting: Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 CONNECTIONS

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
 - 4. Install return-air duct continuously through roof structure.
- B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- C. Where installing piping adjacent to RTUs, allow space for service and maintenance.
- D. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs as specified in Section 260553 "Identification for Electrical Systems."
 - 2. Locate nameplate where easily visible.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. RTU will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to furnace combustion chamber.
4. Inspect for visible damage to compressor, coils, and fans.
5. Inspect internal insulation.
6. Verify that labels are clearly visible.
7. Verify that clearances have been provided for servicing.
8. Verify that controls are connected and operable.
9. Verify that filters are installed.
10. Clean condenser coil and inspect for construction debris.
11. Clean furnace flue and inspect for construction debris.
12. Remove packing from vibration isolators.
13. Inspect operation of relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
26. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
27. Verify operation of remote panel and failure modes. Inspect the following:
 - a. Low-temperature safety operation.
 - b. Filter high-pressure differential alarm.
 - c. Economizer to minimum outdoor-air changeover.

- d. Relief-air fan operation.
- e. Smoke and firestat alarms.

28. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within twelve (12) months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.
- B. Provide video recordings of how the HVAC system equipment physically operates, etc.

END OF SECTION 237416

SECTION 238126 - DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.
- B. Bidders shall provide the minimum system as indicated on Drawings. All systems shall be capable of providing the scheduled capacity at the location of the indoor unit regardless of pipe length. Nominal or catalog capacities will not be accepted.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.7 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

- a. For Compressor: Seven (7) years from date of Substantial Completion.
- b. For Parts: Five (5) years from date of Substantial Completion.
- c. For Labor: One (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design: Trane - Mitsubishi

- B. The following manufacturers shall be allowed to bid as a deductive alternate provided, they meet the scheduled performance indicated on the Drawings:

1. Daikin
2. Mitsubishi
3. Samsung
4. No substitutions.

- C. Equipment must be purchased from a commercial sales office that offers full sales, technical support and has full-service operation with a minimum of ten (10) service trucks. The commercial sales office shall have access to electronic sales, service and technical software for complete submittal packages, and after-market support.

2.2 DUCTLESS SPLIT OUTDOOR UNITS

- A. General:

1. The outdoor unit shall be compatible with the five (5) different types of indoor units (TPCA - ceiling suspending, TPEAD – horizontal ducted, TPKA - wall mounted, TPLA - ceiling cassette, TPVA – ducted air handler). The connected indoor unit shall be of the same capacity as the outdoor unit. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions.

2. The outdoor unit shall be capable of cooling operation down to ambient temperature of 0°F for heat pump systems and -40°F for cooling only systems without additional low ambient controls (optional wind baffle shall be required).
3. The outdoor unit shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.
4. System shall operate at up to a maximum refrigerant tubing length as per manufacturers' recommendations between indoor and outdoor units without the need for line size changes, traps, or additional oil.
5. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.

B. Cabinet:

1. The casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a Munsell 3Y 7.8/1.1 finish.
2. Mounting feet shall be provided and shall be welded to the base of the cabinet and be of sufficient size to afford reliable equipment mount and stability.
3. Easy access shall be afforded to all serviceable parts by means of removable panel sections.
4. The fan grill shall be of ABS plastic.
5. Cabinet mounting and construction shall be sufficient to withstand 155 mph wind speed conditions for use in hurricane condition areas. Mounting, base support, and other installation to meet Hurricane Code Conditions shall be by others.

C. Fan:

1. Models shall be furnished with a single DC fan motor.
2. The fan blade(s) shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated.
3. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent external contact with moving parts.

D. Coil:

1. The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard.
2. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be control by a microprocessor controlled step motor.
3. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ACR Type, meeting ASTM B 280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft/°F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1-inch-thick insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN/ULC S-102.

E. Compressor:

1. The compressor shall be a DC twin-rotor rotary compressor with Variable Speed Inverter Drive Technology.

2. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings.
3. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
4. The outdoor unit shall have an accumulator and high-pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

F. Electrical:

1. The electrical power of the unit shall be 208 volts or 230 volts, single phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
2. Power for the indoor unit shall be supplied from the outdoor unit via Mitsubishi Electric A-Control using three (3) 14-gauge AWG conductors plus ground wire connecting the units.
3. The outdoor unit shall be controlled by the microprocessor located in the indoor unit.
4. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC.
5. The unit shall have Pulse Amplitude Modulation circuit to utilize ninety-eight percent (98%) of input power supply.

G. Operating Range:

Operating Range		Indoor Air Intake Temperature	Outdoor Air Intake Temperature
Cooling	Maximum	D.B. 90°F W.B. 73°F	D.B. 115°F
	Minimum	D.B. 66°F W.B. 59°F	PUY: -20°F*

* Requires wind baffle – without wind baffle: D.B. 23°F

1. Unit shall be able to provide one hundred percent (100%) cooling capacity when operating at TRUZ: 0°F*/TRUY: -20°F outdoor air temperature when a wind baffle is used.

2.3 4-WAY CEILING – RECESSED CASSETTE WITH GRILLE INDOOR UNIT

- A. General: The ceiling-recessed indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Cabinet:

1. All casings, regardless of model size, shall have the same white finish.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
3. Branch shall be allowed from cabinet.
4. Four-way grille shall be fixed to bottom of cabinet allowing two-, three-, or four-way blow.
5. The grille vane angles shall be individually adjustable from a wired remote controller to customize the airflow pattern for the conditioned space.
6. The grille shall allow the unit to be serviceable from the bottom, without the need for an access panel.

C. Fan:

1. The indoor fan shall be statically and dynamically balanced to run on a single motor with permanently lubricated bearings.
2. The indoor unit shall include an AUTO fan setting capable of maximizing energy efficiency by adjusting the fan speed based on the difference between controller set-point and space temperature. The indoor fan shall be capable of five (5) speed settings: Low, Mid1, Mid2, High and Auto.
3. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
4. The indoor unit fan logic must include multiple setting that can be changed to provide optimum airflow based on ceiling height and number of outlets used.
5. The indoor unit vanes shall have five (5) fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
6. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space.
7. Grille shall include a factory-installed "3D i-see" sensor, or equal, to work in conjunction with indoor unit control sequence to prevent unnecessary cooling or heating in unoccupied areas of the zone without decreasing comfort levels. Sensor must detect occupancy (not simply motion) and location of occupants by measuring size and temperature of objects within a 39-foot detecting diameter (based on 8.8 foot mounting height) with 1,856 or more measuring points.

D. Filter: Return air shall be filtered by means of an easily removable, washable filter.

E. Optional Multi-Function Casement:

1. Multi-Function Casement accessory shall install between the unit and the ceiling and allow for additional filtered outside air intake.
2. Filter shall be rated MERV 10 when tested in accordance with ANSI/ASHRAE 52.2 Standard Rated Class 2 under U.L. Standard 900.

F. Coil:

1. The indoor coil shall be of non-ferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
2. The coils shall be pressure tested at the factory.
3. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan.

G. Electrical: The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit, using the Mitsubishi Electric A-Control system. For A-Control, a three (3) conductor AWG-14/16 wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.

2.4 SYSTEM CONTROLS

A. The control system shall consist of a minimum of two (2) microprocessors, one (1) on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from a wireless or wired controller, providing emergency operation and controlling the outdoor unit. The control

signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.

B. Remote Controllers: All remote controllers need to be ordered separately from the unit.

C. CMCN: Remote Controllers Backlit Simple MA Remote Controller (**TAC-YT53CRAU**)

1. The Backlit Simple MA Remote Controller (**TAC-YT53CRAU**) shall be capable of controlling up to sixteen (16) indoor units (defined as one (1) group). The Backlit Simple MA Remote Controller shall be compact in size, approximately 3-inch x 5-inch and have limited user functionality. The Backlit Simple MA supports temperature display selection of Fahrenheit or Celsius. The Backlit Simple MA Remote Controller shall allow the user to change on/off, mode (cool, heat, auto (**R2/WR2-Series** only), dry, setback (**R2/WR2-Series** only) and fan), temperature setting, and fan speed setting and airflow direction. The Backlit Simple MA Remote Controller shall be able to limit the set temperature range from the Backlit Simple MA. The Backlit Simple MA Remote controller shall be capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the Backlit Simple MA Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Backlit Simple MA Remote Controller shall display a 4-digit error code in the event of system abnormality/error.
2. The Backlit Simple MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers (**PAR-FL32MA-E/PAR-FA32MA-E**) or with other Backlit Simple MA Remote Controllers (**TAC-YT53CRAU**), with up to two (2) remote controllers per group.
3. The Backlit Simple MA Remote Controller shall require no addressing. The Backlit Simple MA Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB15 connection terminal on the indoor unit. The Simple MA Remote Controller shall require cross-over wiring for grouping across indoor units.

TAC-YT53CRAU (Backlit Simple MA Remote Controller)			
Item	Description	Operation	Display
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.	Each Group	Each Group
Temperature Setting	Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit/Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1

TAC-YT53CRAU (Backlit Simple MA Remote Controller)			
Item	Description	Operation	Display
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display "test run").	Each Group	Each Group *2
Ventilation Equipment	Up to sixteen (16) indoor units can be connected to an interlocked system that has one (1) LOSSNAY unit.	Each Group	N/A
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group

2.5 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Sections 230923 "Direct Digital Control (DDC) System for HVAC" and 230993 "Sequence of Operations for HVAC."
- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- E. Drain Hose: For condensate.
- F. Monitoring:
 - 1. Monitor constant and variable motor loads.
 - 2. Monitor variable-frequency-drive operation.
 - 3. Monitor economizer cycle.
 - 4. Monitor cooling load.
 - 5. Monitor air distribution static pressure and ventilation air volumes.

2.6 CAPACITIES AND CHARACTERISTICS

- A. Cooling Capacity: Refer to Schedules on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting: Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- F. System shall be installed in accordance with manufacturer's guidelines.
- G. Installing contractor shall install units to comply with building codes.
- H. Ductless split systems shall be installed in such a way as to permit access for routine maintenance.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.
- B. Provide video recordings of how the HVAC system equipment physically operates, etc.

END OF SECTION 238126

SECTION 238129 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes complete VRF HVAC system(s) including, but not limited to, delegated design and the following components to make a complete operating system(s) according to requirements indicated:
 - 1. Medium static ceiling-concealed ducted indoor unit.
 - 2. LEV kit.
 - 3. Outdoor, air-source heat recovery and heat-pump units.
 - 4. System controls.
 - 5. System refrigerant and oil.
 - 6. System condensate drain piping.
 - 7. System refrigerant piping.
 - 8. Metal hangers and supports.
 - 9. Metal framing systems.
 - 10. Fastener systems.
 - 11. Pipe stands.
 - 12. Miscellaneous support materials.
 - 13. Piping and tubing insulation.
 - 14. System control cable and raceways.

1.3 SYSTEM DESCRIPTION

- A. The variable capacity, heat pump and heat recovery air conditioning system shall be a Mitsubishi Electric **CITY MULTI VRF** (Variable Refrigerant Flow) zoning system.
- B. The systems shall consist of outdoor units, Branch Circuit (BC) Controllers (if applicable), indoor fan coil units (FCU), and Direct Digital Controls (DDC) – based on Diamond System Controls. Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to overall system operation. Each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for 10 minutes.
- C. Alternative manufacturers shall be considered if they meet the requirements of this specification i.e., heat recovery design, integrated controls capable of controlling the operation, alarm capability and setpoint adjustment of all other equipment related to the building, including but not limited to, energy recovery ventilators (ERV), air handling units (AHU), and all other HVAC components to the extent directed in the contract documents and to the Owner's satisfaction.

1.4 DEFINITIONS

- A. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

- B. Heat Recovery Heat Pump System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.
- C. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- E. Three-Pipe System Design: One (1) high pressure refrigerant vapor line, one (1) low pressure refrigerant vapor line, and one (1) refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One (1) liquid line and refrigerant vapor line connect HRCUs to associated indoor units.
- F. Two-Pipe System Design: One (1) refrigerant vapor line and one (1) refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One (1) refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two-pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high- and low-pressure refrigerant between indoor units.
- G. VRF: Variable refrigerant flow.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
 - 4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
 - 5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.
 - 6. Include description of control software features.
 - 7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed with supporting calculations.
 - 8. Include refrigerant type and data sheets showing compliance with requirements indicated.
 - 9. For system design software.
 - 10. Indicate location and type of service access.
- B. Shop Drawings: For VRF HVAC systems.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
5. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittals:

1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
3. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
4. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
6. Items penetrating finished ceiling including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Service access panels.

B. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
 - a. Retain copies of Installer certificates on-site and make available on request.
2. For VRF HVAC system manufacturer.
3. For VRF HVAC system provider.

C. Seismic Qualification Data: Certificates, for equipment, 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.

- D. Product Certificates: For each type of product.
- E. Product Test Reports: Where tests are required, for each product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.
- F. Source quality-control reports.
- G. Field quality-control reports.
- H. Sample Warranties: For manufacturer's warranties.
1. Provide Manufacturer's extended Warrantee for Contractor Certified installation.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
1. Nationally recognized manufacturer of VRF HVAC systems and products.
 2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of ten (10) years within time of bid.
 3. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.
 4. VRF HVAC systems must be purchased from manufacturer with a commercial sales office that offers full sales support, technical support, and service operation with a minimum of ten (10) service trucks. The commercial sales office must have access to electrical sales, service, and technical software for complete submittal package and aftermarket support
 5. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.
 6. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
 7. Having full-time in-house employees for the following:

- a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing, and quality control.
 - d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
 - e. Owner training.
 - B. Factory-Authorized Service Representative Qualifications:
 - 1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
 - 2. In-place facility located within fifty (50) miles of Project.
 - 3. Demonstrated past experience with products being installed for period within five (5) consecutive years before time of bid.
 - 4. Demonstrated past experience on five projects of similar complexity, scope, and value.
 - a. Each person assigned to Project shall have demonstrated past experience.
 - 5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
 - 6. Service and maintenance staff assigned to support Project during warranty period.
 - 7. Product parts inventory to support ongoing system operation for a period of not less than five (5) years after Substantial Completion.
 - 8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.
 - C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.
 - 1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
 - 2. Installer certification shall be valid and current for duration of Project.
 - 3. Retain copies of Installer certificates on-site and make available on request.
 - 4. Each person assigned to Project shall have demonstrated past experience.
 - a. Demonstrated past experience with products being installed for period within five (5) consecutive years before time of bid.
 - b. Demonstrated past experience on five (5) projects of similar complexity, scope, and value.
 - 5. Installers shall have staffing resources of competent, trained, and experienced full-time employees that are assigned to execute work according to schedule.
 - D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Deliver and store products in a clean and dry place.
 - B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Unit shall be stored and handled according to the manufacturer's recommendations.
- E. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
 - 1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
 - 2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
- F. Replace installed products damaged during construction.
- G. A full charge of refrigerant for the condensing unit only shall be provided in the condensing unit for shipping from the factory.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period:
 - a. For Compressor: Ten (10) years from date of Substantial Completion.
 - b. For Parts, Including Controls: Ten years from date of Substantial Completion.
 - c. For Labor: Contractor shall provide one (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design: Trane **CITY MULTI** two-pipe system, or Engineer-approved VRF system manufacturer from the list below:
 - 1. Daikin
 - 2. Mitsubishi
 - 3. Samsung
 - 4. No substitutions.
- B. The Engineer with the assistance of a Manufacturer's Representative have designed the project as a two-pipe system. Contractor's who submit on a three-pipe system will be responsible for all design revisions and additional/alternative components for the installation of a fully operating three-pipe system at no additional cost to the Owner.

- C. Manufacturers must meet or exceed heating and cooling capacities listed and module footprints listed. Any mechanical, structural, or electrical costs impacts due to alternate modules size will be responsibility of substitute VRF manufacturer.
- D. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:
 - 1. Indoor and outdoor units, including accessories.
 - 2. Controls and software.
 - 3. HRCUs.
 - 4. Energy Recovery Ventilators (ERV's).
 - 5. Refrigerant isolation valves.
 - 6. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

- A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
 - 1. Two-pipe system design.
 - 2. System(s) operation, air-conditioning heat pump or heat recovery as indicated on Drawings.
 - 3. Each system with one refrigerant circuit shared by all indoor units connected to system.
- 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. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.
- D. ASHRAE Compliance:
 - 1. ASHRAE 15: For safety code for mechanical refrigeration.
 - 2. ASHRAE 62.1: For indoor air quality.
 - 3. ASHRAE 135: For control network protocol with remote communication.
 - 4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.
- E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified specialist, as defined in Section 014000 "Quality Requirements," to design complete and operational VRF HVAC system(s) complying with requirements indicated.
 - 1. Provide system refrigerant calculations.
 - a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
 - b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.

2. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.
 3. System Refrigerant Piping and Tubing:
 - a. Arrangement: Arrange piping to interconnect indoor units, HRCUs, and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.
 - b. Routing: exposed piping above ceilings and behind walls to maximum extent possible.
 - c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated.
 4. System Controls:
 - a. Network arrangement.
 - b. Network interface with other building systems.
 - c. Product selection.
 - d. Sizing.
- B. Service Access:
1. Provide and document service access requirements.
 2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
 3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
 4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
 5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
 6. Comply with OSHA regulations.
- C. System Design and Installation Requirements:
1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
 2. Where manufacturer's requirements differ from requirements indicated, contact Engineer for direction. The most stringent requirements should apply unless otherwise directed in writing by Engineer.
- D. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation. Isolation Valves to be provided by mechanical contractor.
- E. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:
1. Range acceptable to manufacturer.
- F. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.
- G. Outdoor Conditions: Suitable for outdoor ambient conditions encountered.

1. Design equipment and supports to withstand wind loads of governing code.
 2. Design equipment and supports to withstand snow and ice loads of governing code.
- H. Seismic Performance: VRF HVAC system(s) shall withstand the effects of earthquake motions determined according to governing code.
- I. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
1. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
 2. Outdoor: Within ordinance of governing authorities; however, outdoor units shall be of the quietest sound levels available from the manufacturer.
 3. Sound requirements for each indoor unit space.
 - a. Classrooms shall be less than or equal to 35 dBA (55dBC).
 - b. Offices, Cafeteria, Offices, Storage Rooms, and other miscellaneous areas shall be less than or equal to 40 dBA (60dBC).
- J. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.
- K. Capacities and Characteristics: As indicated on Drawings.
- 2.4 MEDIUM STATIC CEILING-CONCEALED DUCTED INDOOR UNIT
- A. Description: The ceiling-concealed ducted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.
- B. Unit Cabinet:
1. The unit shall be ceiling-concealed, ducted—with a 2-position, field adjustable return and a fixed horizontal discharge supply.
 2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
- C. Fan:
1. Indoor unit shall feature multiple external static pressure settings ranging from 0.14 to 0.60 in. WG.
 2. The indoor unit fan shall be an assembly with statically and dynamically balanced Sirocco fan(s) direct driven by a single motor with permanently lubricated bearings.
 3. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function
- D. Filter: Return air shall be filtered by means of a standard factory installed return air filter.
- E. Coil:
1. The indoor coil shall be of non-ferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
 2. The coils shall be pressure tested at the factory.

3. Coil shall be provided with a sloped drain pan. Units without sloped drain pans which must be installed cockeyed to ensure proper drainage are not allowed.
4. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 27 inches above the condensate pan.

F. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

G. Controls:

1. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
2. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
3. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
4. System shall auto-restart on Power Failure. Each indoor unit shall be able to lose power without taking down the entire system

2.5 LEV KIT (FOR INTEGRATION INTO NON-VRF INDOOR UNITS)

- A. General: The PAC-AH001-1 Linear Expansion Valve Kit shall be a dedicated custom package to allow the integration of **CITYMULTI** VRF with Trane air handling units. The package comprises of the following components:

1. **PAC-AH001-1** Controller
2. NEMA 1 Rated Control Panel Enclosure
3. Linear Expansion Valves (See Schedule for Applicable Sizes):
 - a. **PAC-LV24AC-1** (2-ton nominal)
 - b. **PAC-LV48AC-1** (4-ton nominal)
 - c. **PAC-LV60AC-1** (5-ton nominal)
 - d. **PAC-LV96AC-1** (8-ton nominal)
 - e. **PAC-LV120AC-1** (10-ton nominal)
4. Thermistors **TH-21/22/23/24** (return air, liquid line, suction line, supply air)

- B. Each Linear Expansion Valve shall be supplied with integrated power cable for termination at the **PAC-AH001-1** control panel in the field.

- C. Control Panel: The **PAC-AH001-1** control panel shall be NEMA-1 or equivalent rated for installation indoor or in a suitably rated enclosure. The control panel shall be installed in the field in close proximity to the custom direct expansion coil (up to 16') to facilitate the field wiring of control and power wiring. The PAC-AH001-1 control panel shall have the following input/output terminals to facilitate interlocks and communication with third party control systems:

1. ON/OFF Input (A1-A2)
2. Analog Input – Supply/Return Air Set-Point Control (B1-B2)
3. Damper Signal Output (D1-D2)
4. Error Signal Output (E1-E2)

5. Float Switch Input (FS1-FS2)
6. Heater Output Signal (H1-H2)
7. Operation Signal Output
8. Error Signal Output (OE)
9. Operation Signal Heating (OH)
10. Operation Signal Cooling (OC)
11. Operation Signal Defrost (OD)
12. Three Speed Fan Signal Output

- D. Electrical: The unit electrical power shall be 208/230 volts, 1-phase, 60 Hertz. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
- E. Controls: This unit shall use controls provided by Mitsubishi Electric Trane HVAC to perform functions necessary to operate the system. Please refer to the controls section of the LEV Control Box and Valve Assemblies Application Guide for details on controllers and other control options.
- F. Installation: LEV Installation General Notes:
 1. The Linear Expansion Valve (LEV) kit includes at least one (1) valve assembly per distributor, an LEV Control box for each distributor, and two (2) refrigerant temperature thermistors and two (2) air temperature thermistors for each LEV control box.
 2. The Linear Expansion Valve Controller must be within 16 feet wire length of the valve assembly.
 3. LEVs and air handler controllers shall be located indoors or in a watertight outdoor enclosure. LEV kits are not suitable for hazardous locations both indoor and outdoor.

2.6 OUTDOOR, AIR-SOURCE, HEAT-RECOVERY AND HEAT PUMP UNITS

- A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
 1. Specially designed for use in systems with simultaneous heating and cooling (heat recovery) or heat pump (not simultaneous).
 2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
 3. All units installed shall meet the heating and cooling capacities as shown in the schedule at design outdoor air temperatures. If a substitute manufacturer other than the Basis-of-Design manufacturer is selected, any additional material, cost, and labor to meet low ambient heating operating condition and performance shall be incurred by the Contractor.
- B. Design Basis Outdoor Unit:
 1. The **R2-Series** and **Y-Series** outdoor units shall be used specifically with **CITY MULTI** VRF components. The outdoor units shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
 2. All units requiring factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If a substitute manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.

C. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

D. Compressor and Motor Assembly:

1. One (1) or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to nineteen to five percent (19-5%) of rated capacity, depending upon unit size. Non-inverter driven compressors, which result in larger inrush currents and require larger wire sizing, shall not be allowed.
2. Protection: Integral protection against the following:
 - a. High refrigerant pressure safety switch.
 - b. Low oil level.
 - c. High oil temperature.
 - d. Thermal and overload.
 - e. Voltage fluctuations and over-current protection.
 - f. Phase failure and phase reversal.
 - g. DC bus protection.
 - h. Short-cycling of compressor.
3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Accumulator with refrigerant level sensors and controls.
7. Crankcase heaters with integral control to maintain safe operating temperature.
8. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
9. Fusible plug.

E. Refrigerant:

1. R454B refrigerant shall be required for outdoor unit systems under 65 MBH.
2. R410A and R32 refrigerant shall be required for outdoor unit systems 65 MBH and above.
3. Polyolester (POE) oil shall be required.

F. Condenser Coil Assembly:

1. Plate Fin Coils:
 - a. Casing: Aluminum, galvanized, or stainless steel.
 - b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
 - c. Tubes: Copper, of diameter and thickness required by performance.
 - d. The outdoor coil shall be of non-ferrous construction with lanced or corrugated plate fins on copper tubing.
 - e. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
 - f. The coil shall be protected with an integral metal guard.

- g. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
- G. Condenser Fan and Motor Assembly:
 - 1. Fan(s): Propeller type.
 - a. Direct-drive, variable-speed, propeller-type fan arrangement.
 - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
 - c. Statically and dynamically balanced.
 - d. Vertical discharge airflow.
 - 2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
 - 3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
 - 4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 - 5. Speed Settings and Control: Variable speed with a speed range of least seventy-five percent (75%).
 - 6. Vibration Control: Integral isolation to dampen vibration transmission.
- H. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
 - 1. Provide a factory drain pan heater to prevent ice buildup on condensing unit drain pan during long periods of heating operation.
- I. Unit Controls:
 - 1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
 - 2. The outdoor unit shall have the capability of up to 8 levels of demand control for each refrigerant system.
 - 3. Factory-Installed Controller: Configurable digital control.
 - 4. Factory-Installed Sensors:
 - a. Refrigerant suction temperature.
 - b. Refrigerant discharge temperature.
 - c. Outdoor air temperature.
 - d. Refrigerant high pressure.
 - e. Refrigerant low pressure.
 - f. Oil level.
 - g. High efficiency oil separator plus additional logic controls to ensure adequate compressor oil volume is maintained.
 - 5. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch, and equalization of run time between multiple similar components.
 - 6. VRF manufacturer must be able to do both simultaneous defrost and reverse defrost based on ambient temperature on both twinned and single modules. Manufacturer must bypass refrigerant in Branch Device and not flow refrigerant through indoor units in reverse defrost mode. During simultaneous mode Indoor units shall automatically switch to low fan speed to keep high leaving air temp off indoor units.

7. Communication: Network communication with indoor units and other outdoor unit(s).
8. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
9. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

J. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz or 460 volts, 3-phase, 60 hertz according to the schedule.
4. The outdoor unit shall be controlled by integral microprocessors.
5. The control circuit between the indoor units, HRCU's and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
6. Disconnecting Means: Unit shall be furnished with factory-mounted (preferably) circuit breaker or switch, complying with NFPA 70.
7. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
8. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
9. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

K. Unit Hardware: Zinc-plated steel, or stainless steel.

L. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.7 HEAT RECOVERY CONTROL UNITS (HRCUs) FOR HEAT RECOVERY SYSTEMS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections. The HRCUs, or BC (Branch Circuit) Controllers, shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple units that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling are not allowed.
4. HRCUs shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation.
5. HRCUs shall be mounted indoors, with access and service clearance provided for each controller.
6. HRCUs shall be suitable for use in plenums in accordance with UL199.

B. Cabinet:

1. Galvanized-steel construction.
2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
3. The unit shall house two (2) tube-in-tube heat exchangers.
4. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
5. Mounting: Manufacturer-designed provisions for field installation.
6. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
 - a. All Branch Devices shall have bottom access for service; devices that require top access shall pay for additional GC costs to provide ceiling or plenum space height increase to meet their published service clearances and be considered a substitution only. Substitution approved VRF manufacturers shall be responsible for all costs associated with additional Branch Device quantities, including but not limited additional electrical costs, refrigerant expansion joints and design, structural changes, and additional service/access panels.
7. System Design: Each VRF System shall be provided with at least (1) spare port on one (1) of the downstream branch controller(s) to allow for future expansion and system changes as necessary.

C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

D. Refrigeration Assemblies and Specialties:

1. Specially designed by manufacturer for type of two-pipe VRF HVAC system being installed.
2. All HRCU refrigerant pipe connections shall be brazed or flared.
3. Each refrigerant branch circuit shall have multiple, two-position refrigerant control valve(s) to control refrigerant flow.
4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system. Isolation valves shall be provided the mechanical contractor.
5. Each branch circuit connection shall be fitted with service shut-off valves and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.
6. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

E. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Features and Functions: Self-diagnostics, fuse protection.
4. Communication: Network communication with indoor units and outdoor unit(s).
5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

F. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.
7. The unit electrical power shall be 208/230 volts, 1 phase, 60 Hertz.
8. The unit shall be capable of satisfactory operation within voltage limits of 187-228 (208V/60Hz).
9. The HRCU shall be controlled by integral microprocessors.
10. The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

G. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.8 SYSTEM CONTROLS

A. General Requirements:

1. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. The BMS shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface or any local system touch screen controllers.
 - a. The Basis-of-Design manufacturer's control system operates at 30VDC. Controller power and communications shall be via a common non-polar communications bus.
 - 1) Equipment manufacturer to provide central controller and any expansion controller needed to monitor VRF system. Provide BACnet interface for communicating with BMS.
 - 2) Room Temperature Thermostat: Provide MA Remote Controller for each zone.
 - 3) Power loss to one (1) indoor unit will not cause system shutdown and the system will continue to operate normally. Any cost from system shutdown due to indoor unit power loss from substitute manufacturer will be one hundred percent (100%) incurred on the installing contractor.
 - b. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.
2. System shall be furnished with energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.

3. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.
4. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.
5. System shall be capable of email generation for remote alarm annunciation.
6. Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in the manufacturer's specific controls system configuration and operation. The representative shall provide proof of certification in training indicating successful completion of no more than two (2) years prior to system installation and shall consist of a minimum of one (1), eight (8) hour period completed during normal working hours.
7. Network: Indoor units, HRCUs, and outdoor units shall include integral controls and connect through a manufacturer-selected control network.
8. Network Communication Protocol: Manufacturer proprietary and open control communication between interconnected units.
9. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:
 - a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.
 - b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.
 - c. Integration shall include control, monitoring, scheduling, change of value notifications, data trending and programming.
10. Operator Interface:
 - a. Operators shall interface with system and unit controls through the following:
 - 1) Operator interfaces integral to controllers.
 - 2) Owner-furnished PC connected to central controller(s).
 - 3) Web interface through web browser software.
 - 4) Integration with Building Automation System.
 - b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:
 - 1) On/off control.
 - 2) Temperature set-point adjustment.

B. VRF HVAC System Operator Software for PC:

1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.

6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
9. Supports Multiple Languages: English.
10. Supports Imperial and Metric Temperature Units: Fahrenheit and Celsius.
11. Displays service notifications and error codes.
12. Monitors and displays up to three thousand (3000) item error history and ten thousand (10000) item operation history for regular reporting and further archiving.
13. Monitors and displays cumulative operating time of indoor units.
14. Able to disable and enable operation of individual controllers for indoor units.
15. Information displayed on individual controllers shall also be available for display.
16. Information displayed for outdoor units, including refrigerant high- and low-pressures, percent capacity and alarm.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.
 - a. Include multiple interconnected controllers as required. A minimum of one (1) TE200 Controller with additional expansion modules capable of interconnecting the remaining equipment is anticipated.
2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
 - a. Sets schedule for daily, weekly, and annual events.
 - b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.
4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start-feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Information displayed for outdoor units, including refrigerant high and low pressures, percent capacity and alarm.
11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.

2.9 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
 2. ASHRAE 34, Class A1 refrigerant classification.
 3. R-454B refrigerant on systems below 65 MBH.
 4. R-410A and R-32 refrigerant on systems 65 MBH and larger.
- B. Oil: As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.
1. Polyolester (POE) oil shall be required for the Basis-of-Design manufacturer's equipment. Prior to bidding, manufacturers using substitute oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for substitute oil with list of local suppliers stocking substitute oil for approval at least two (2) weeks prior to bidding.

2.10 SYSTEM CONDENSATE DRAIN PIPING

- A. If more than one (1) material is listed, material selection is Contractor's option.
- B. Copper Tubing:
1. Drawn-Temper Tubing: According to ASTM B 88, Type L or Type DWV according to ASTM B 306.
 2. Wrought-Copper Fittings: ASME B16.22.
 3. Wrought-Copper Unions: ASME B16.22.
 4. Solder Filler Metals: ASTM B 32, lead-free alloys, and water-flushable flux according to ASTM B 813.
- C. PVC plastic pipe according to ASTM D 1785, Schedule 40, with socket-type pipe fittings according to ASTM D 2466 and solvent cement according to ASTM D 2564, primer according to ASTM F 656.

2.11 SYSTEM REFRIGERANT PIPING

- A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.
- B. Refrigerant Piping:
1. Copper Tube: ASTM B 280, Type ACR, annealed and drawn temper.
 2. Wrought-Copper Fittings: ASME B16.22.
 3. Brazing Filler Metals: AWS A5.8.
- C. Refrigerant Tubing Kits:
1. Furnished by VRF HVAC system manufacturer.
 2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
 3. Standard one-piece length for connecting to indoor units.
 4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
 5. Factory Charge: Dehydrated air or nitrogen.
- D. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

E. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least twenty (20) years.
3. Valve Connections: Flare or sweat depending on size.

2.12 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized or copper-coated steel.

B. Plastic Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, galvanized steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.

2.13 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated, pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel for use indoors and of stainless steel for use outdoors.
6. Metallic Coating for Use Indoors: Electroplated zinc, hot-dip galvanized, or mill galvanized.
7. Plastic Coating for Use Outdoors: PVC, epoxy or polyester.

2.14 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded, zinc-coated steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated or stainless-steel.
2. Outdoor Applications: Stainless-steel.

2.15 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Stainless-steel.
 - 3. Vertical Members: Two (2) or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One (1) or more; plastic.
 - 3. Vertical Members: Two (2) or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.16 MISCELLANEOUS SUPPORT MATERIALS

- A. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, non-corrosive, and non-gaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
- B. Structural Steel: ASTM A 36, carbon-steel plates, shapes, and bars; galvanized.
- C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

2.17 PIPING AND TUBING INSULATION

- A. Comply with requirements in Section 230700 "HVAC Insulation" for system piping insulation requirements.
- B. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:
 - a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C 534, Type I for tubular materials.
 - b. Indoors: ¾-inch-thick.
 - c. Outdoors: 1-inch-thick.
 2. Field-Applied Jacket:
 - a. Concealed: None required.
 - b. Indoors, Exposed to View: PVC, 20 mils thick, color selected by Architect and Owner from manufacturer's entire range.
 - c. Outdoors, Exposed to View: Aluminum, smooth, 0.020-inch-thick.
- C. Refrigerant Tubing Insulation and Jacket Requirements:
1. Flexible Elastomeric Insulation:
 - a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C 534, Type I for tubular materials.
 - b. Indoors: 1-inch-thick.
 - c. Outdoors: 1-inch-thick.
 2. Field-Applied Jacket:
 - a. Concealed: None required.
 - b. Indoors, Exposed to View: PVC, color selected by Architect and Owner from manufacturer's entire range, 20 mils thick.
 - c. Outdoors, Exposed to View: Aluminum, smooth, 0.020-inch-thick.
- D. Flexible Elastomeric Insulation Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
- F. Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
- 2.18 SYSTEM CONTROL CABLE
- A. Cable Rating: Listed and labeled for application according to NFPA 70.
1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - a. Flame Travel Distance: 60 inches or less.
 - b. Peak Optical Smoke Density: 0.5 or less.
 - c. Average Optical Smoke Density: 0.15 or less.
 2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

B. Low-Voltage Control Cabling:

1. Paired Cable: NFPA 70, Type CMG.
 - a. One-pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
 - b. PVC insulation.
 - c. Braided or foil shielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1685.

C. TIA-485A Network Cabling:

1. Standard Cable: NFPA 70, Type CMG.
 - a. Paired, one-pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1685.

D. Ethernet Network Cabling: TIA-568-C.2 Category 6 cable with RJ-45 connectors.

1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.
2. Conductors: 100-ohm, 23 AWG solid copper.
3. Shielding: Shielded twisted pairs (FTP).
4. Cable Rating: By application.
5. Jacket: Gray or blue thermoplastic.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

2.19 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect factory-assembled equipment.
- B. Equipment will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

- C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.
- D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.
- E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.
- F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
- G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

- A. Clearance:
 - 1. Maintain manufacturer's recommended clearances for service and maintenance.
 - 2. Maintain clearances required by governing code.
- B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.
 - 1. Loose components shall be installed by manufacturer's service representative or system Installer under supervision of manufacturer's service representative.
- C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF INDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8-inch.
- C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
- D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.
- E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
- F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
- G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25-inch.

- H. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.
- I. Floor-mounted units located in mechanical rooms.
- J. Install floor-mounted units on support structure indicated on Drawings.
- K. Install floor-mounted units on cast-in-place concrete equipment bases.
- L. Attachment: Install hardware for proper attachment to supported equipment.
- M. Grouting: Place grout under equipment supports and make bearing surface smooth.

3.4 INSTALLATION OF OUTDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Install outdoor units on support structures indicated on Drawings.
- C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases.
 - 1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 2. Grouting: Place grout under equipment supports and make bearing surface smooth.
- D. Roof-Mounted Installations: Install outdoor units on equipment supports. Anchor units to supports with removable, stainless-steel fasteners.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping and tubing to permit valve servicing.
- F. Install piping and tubing at indicated slopes.
- G. Install piping and tubing free of sags.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping and tubing to allow application of insulation.
- J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

- K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

- A. General Requirements for Drain Piping and Tubing:
 - 1. Install a union in piping at each threaded unit connection.
 - 2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
 - 3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:
 - a. Details indicated on Drawings.
 - b. Manufacturer's requirements.
 - c. Governing codes.
 - d. In the absence of requirements, comply with requirements of ASHRAE handbooks.
 - 4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
 - 5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.
- B. Gravity Drains: Slope piping from unit connection toward drain termination at a constant slope of not less than one percent (1%).
- C. Pumped Drains: If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 INSTALLATION OF REFRIGERANT PIPING

- A. Refrigerant Tubing Kits:
 - 1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
 - 2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet. Minimum rod size, ¼-inch.
 - 3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.
- B. Install refrigerant piping according to ASHRAE 15 and governing codes.
- C. Select system components with pressure rating equal to or greater than system operating pressure.
- D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

- E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- F. Install refrigerant piping and tubing in protective conduit where installed belowground.
- G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.
- H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:
 - 1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- I. When brazing, remove or protect components that could be damaged by heat.
- J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.
- K. Joint Construction:
 - 1. Ream ends of tubes and remove burrs.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
 - 3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
 - a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
 - b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.8 INSTALLATION OF METAL HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- B. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Comply with MFMA-103 for metal framing system selections and applications that are not specified.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners, for use in lightweight concrete or concrete slabs less than 4 inches thick, in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
 3. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- F. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel.
1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Piping and Tubing Insulation:
1. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 2. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048-inch-thick.
- N. Horizontal-Piping Hangers and Supports: Install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 4. Multiple horizontal pipes located indoors may use metal framing systems with split clamp attachment for each pipe in lieu of individual clevis hangers.
 5. Pipe stands for horizontal pipes located outdoors.
 6. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 7. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

- O. Horizontal Piping Hanger Spacing and Rod Size: Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:
1. Sizes through NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4-inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4-inch.
 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8-inch.
 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8-inch.
 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8-inch.
 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8-inch.
 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8-inch.
- P. Plastic Pipe Hanger and Support Spacing:
1. Space hangers and supports according to pipe manufacturer's written instructions for service conditions.
 2. Maximum spacing, 5 feet; minimum rod size, 1/4-inch.
- Q. Vertical-Piping Clamps: Install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): If longer ends are required for riser clamps.
- R. Support vertical runs at roof, at each floor, and at midpoint intervals between floors, not to exceed 10 feet.
- S. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified.
- T. Use hangers, supports, and attachments with galvanized coatings unless otherwise indicated.
- U. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- V. Trim excess length of continuous-thread hanger and support rods to 1-inch.
- W. Hanger-Rod Attachments: Install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- X. Building Attachments: Install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

3.9 INSTALLATION OF PIPING AND TUBING INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.
- B. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Valves and Pipe Specialties:
 1. Install pre-formed valve covers manufactured of same material as pipe insulation when available.
 2. When pre-formed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 1. Apply two (2) continuous beads of adhesive to seams and joints, one (1) bead under lap and the finish bead along seam and joint edge.
- E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 INSTALLATION OF DUCT, ACCESSORIES, AND AIR OUTLETS

- A. Where installing ductwork adjacent to equipment, allow space for service and maintenance.
- B. Comply with requirements for metal ducts specified in Section 233113 "Metal Ducts."
- C. Comply with requirements for air duct accessories specified in Section 233300 "Air Duct Accessories."
- D. Comply with requirements for flexible ducts specified in Section 233346 "Flexible Ducts."
- E. Comply with requirements for air diffusers, registers and grilles specified in Section 233713 "Diffusers, Registers and Grilles."

3.11 ELECTRICAL INSTALLATION

- A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.
- B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.
 - 1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.
- C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.
- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.
- F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least ½-inch-high.
 - 2. Locate nameplate or label where easily visible.
- G. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.
 - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2½ inches deep.
 - 2. Outlet boxes for cables shall be no smaller than 4 inches square by 1½ inches deep with extension ring sized to bring edge of ring to within 1/8-inch of the finished wall surface.
 - 3. Flexible metal conduit shall not be used.
- H. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- I. Install manufactured conduit sweeps and long-radius elbows if possible.

- J. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.12 SOFTWARE

A. Cybersecurity:

1. Software:

- a. Coordinate security requirements with IT department.
- b. Ensure that latest stable software release is installed and properly operating.
- c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight (8) characters in length. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

- a. Coordinate location and access requirements with IT department.
- b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
- c. Disable dual network connections.

3.13 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with NECA 1.

B. Installation Method:

1. Install cables in raceways except as follows:

- a. Within equipment and associated control enclosures.
- b. In accessible ceiling spaces where open cable installation method may be used.
- c. In gypsum board partitions where cable may be enclosed within wall cavity.

2. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:

- 1. Comply with TIA-568-C Series of standards.
- 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
- 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
- 4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.
- 5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
- 6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
- 8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals.
15. Do not bend cables in a radius less than ten (10) times the cable OD.
16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist balanced twisted-pair cables more than ½-inch at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.14 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.15 GROUNDING INSTALLATION

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.16 IDENTIFICATION

- A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."

- B. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.17 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.
 - 1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
 - a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.
 - 2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.
 - a. First Visit: Kick-off meeting.
 - b. Second Visit: At approximately twenty-five percent (25%) completion of system(s).
 - c. Third Visit: At approximately fifty percent (50%) completion of system(s).
 - d. Fourth Visit: At approximately seventy-five percent (75%) completion of system(s).
 - e. Fifth Visit: Final inspection before system startup.
 - 3. Kick-off Meeting:
 - a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
 - b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
 - c. Meeting shall cover the following as a minimum requirement:
 - 1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
 - 2) Manufacturer's installation requirements specific to systems being installed.
 - 3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
 - 4) Required field activities related installation of VRF HVAC system.
 - 5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.
 - 4. Site Visits: Activities for each site visit shall include the following:
 - a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.

- b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
 - c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
 - d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
 - e. Issue a report for each visit, documenting the visit.
 - 1) Report to include name and contact information of individual making the visit.
 - 2) Date(s) and time frames while on-site.
 - 3) Names and contact information of people meeting with while on-site.
 - 4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.
5. Final Inspection before Startup:
- a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
 - b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
 - c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
 - d. Inspection reports for indoor units shall include, but not be limited to, the following:
 - 1) Unit designation on Drawings.
 - 2) Manufacturer model number.
 - 3) Serial number.
 - 4) Network address, if applicable.
 - 5) Each equipment setting.
 - 6) Mounting, supports, and restraints properly installed.
 - 7) Proper service clearance provided.
 - 8) Wiring and power connections correct.
 - 9) Line-voltage reading(s) within acceptable range.
 - 10) Wiring and controls connections correct.
 - 11) Low-voltage reading(s) within an acceptable range.
 - 12) Controller type and model controlling unit.
 - 13) Controller location.
 - 14) Temperature settings and readings within an acceptable range.
 - 15) Humidity settings and readings within an acceptable range.
 - 16) Condensate removal acceptable.
 - 17) Fan settings and readings within an acceptable range.
 - 18) Unit airflow direction within an acceptable range.
 - 19) If applicable, fan external static pressure setting.
 - 20) Filter type and condition acceptable.
 - 21) Noise level within an acceptable range.
 - 22) Refrigerant piping properly connected and insulated.
 - 23) Condensate drain piping properly connected and insulated.
 - 24) If applicable, ductwork properly connected.
 - 25) If applicable, external interlocks properly connected.

- 26) Remarks.
- e. Inspection reports for outdoor units shall include, but not be limited to, the following:
- 1) Unit designation on Drawings.
 - 2) Manufacturer model number.
 - 3) Serial number.
 - 4) Network address, if applicable.
 - 5) Each equipment setting.
 - 6) Mounting, supports, and restraints properly installed.
 - 7) Proper service clearance provided.
 - 8) Wiring and power connections correct.
 - 9) Line-voltage reading(s) within acceptable range.
 - 10) Wiring and controls connections correct.
 - 11) Low-voltage reading(s) within an acceptable range.
 - 12) Condensate removal acceptable.
 - 13) Noise level within an acceptable range.
 - 14) Refrigerant piping properly connected and insulated.
 - 15) Condensate drain piping properly connected and insulated.
 - 16) Remarks.
- f. Inspection reports for indoor, dedicated outdoor air ventilation units shall include, but not be limited to, the following:
- 1) Unit designation on Drawings.
 - 2) Manufacturer model number.
 - 3) Serial number.
 - 4) Network address, if applicable.
 - 5) Each equipment setting.
 - 6) Mounting, supports, and restraints properly installed.
 - 7) Proper service clearance provided.
 - 8) Wiring and power connections correct.
 - 9) Line-voltage reading(s) within acceptable range.
 - 10) Wiring and controls connections correct.
 - 11) Low-voltage reading(s) within an acceptable range.
 - 12) Controller type and model controlling unit.
 - 13) Controller location.
 - 14) Temperature settings and readings within an acceptable range.
 - 15) Humidity settings and readings within an acceptable range.
 - 16) Condensate removal acceptable.
 - 17) Fan settings and readings within an acceptable range.
 - 18) Fan external static pressure setting.
 - 19) Filter type and condition acceptable.
 - 20) Noise level within an acceptable range.
 - 21) Refrigerant piping properly connected and insulated.
 - 22) Condensate drain piping properly connected and insulated.
 - 23) Automatic dampers properly installed and operating.
 - 24) Ductwork properly connected.
 - 25) If applicable, external interlocks properly connected.
 - 26) Remarks.
- g. Inspection reports for energy recovery ventilators shall include, but not be limited to, the following:
- 1) Unit designation on Drawings.

- 2) Manufacturer model number.
- 3) Serial number.
- 4) Network address, if applicable.
- 5) Each equipment setting.
- 6) Mounting, supports, and restraints properly installed.
- 7) Proper service clearance provided.
- 8) Wiring and power connections correct.
- 9) Line-voltage reading(s) within acceptable range.
- 10) Wiring and controls connections correct.
- 11) Low-voltage reading(s) within an acceptable range.
- 12) Controller type and model controlling unit.
- 13) Controller location.
- 14) Temperature settings and readings within an acceptable range.
- 15) Humidity readings.
- 16) Condensate removal acceptable.
- 17) Fan settings and readings within an acceptable range.
- 18) Fan external static pressure setting.
- 19) Filter type and condition acceptable.
- 20) Noise level within an acceptable range.
- 21) Automatic dampers properly installed and operating.
- 22) Ductwork properly connected.
- 23) If applicable, external interlocks properly connected.
- 24) Remarks.

- h. Installer shall provide manufacturer with the requested documentation and technical support during inspection.
- i. Installer shall correct observed deficiencies found by the inspection.
- j. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
- k. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
- l. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Manufacturer's Representative to assist in 3rd party commissioning.

C. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.2 times VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record the following information for each test:
 - a. Name of person starting test, company name, phone number, and e-mail address.
 - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
 - c. Detailed description of extent of tubing tested.
 - d. Date and time at start of test.
 - e. Test pressure at start of test.
 - f. Outdoor temperature at start of test.
 - g. Name of person ending test, company name, phone number, and e-mail address.
 - h. Date and time at end of test.
 - i. Test pressure at end of test.
 - j. Outdoor temperature at end of test.
 - k. Remarks:
5. Submit test reports for Project record.

E. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 1 hour with no change.
4. Prepare test report to record the following information for each test:
 - a. Name of person starting test, company name, phone number, and e-mail address.
 - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
 - c. Detailed description of extent of tubing tested.
 - d. Date and time at start of test.
 - e. Test pressure at start of test.
 - f. Outdoor temperature at start of test.
 - g. Name of person ending test, company name, phone number, and e-mail address.
 - h. Date and time at end of test.
 - i. Test pressure at end of test.
 - j. Outdoor temperature at end of test.
 - k. Remarks:
5. Submit test reports for Project record.
6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

F. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.

2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

G. Products will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports.

3.18 STARTUP SERVICE

A. Engage a VRF Technical Specialist to performance Startup Assistance. Contractor to review startup checklist with Technical Specialist prior to startup.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each indoor unit's response to demand for cooling and heating.
3. Check each indoor unit's response to changes in airflow settings.
4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.
 - a. All available system operating parameters shall be included in the information submitted.

E. Witness:

1. Invite Architect and Owner to witness startup service procedures.
2. Provide written notice not less than fourteen (14) business days before start of startup service.

3.19 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

- C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.
- D. Occupancy Adjustments: When requested within twelve (12) months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.

3.20 PROTECTION

- A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.
- B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.
- C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.
- D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.21 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve (12) months' full maintenance by skilled employees of system Installer who are manufacturer's authorized service representative. Include two (2) service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.22 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least thirty (30) days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.23 DEMONSTRATION

- A. Engage a VRF Technical Specialist to train Owner's maintenance personnel to adjust, operate, and maintain entire system.
- B. Instructor:
 - 1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
 - 2. Instructor's credentials shall be submitted for review before scheduling training.
 - 3. Instructor(s) primary job responsibility shall be Owner training.

4. Instructor(s) shall have not less than three years of training experience with VRF HVAC system manufacturer and past training experience on at least three (3) projects of comparable size and complexity.
- C. Schedule and Duration:
1. Schedule training with Owner at least twenty (20) business days before first training session.
 2. Training shall occur before Owner occupancy.
 3. Training shall be held at mutually agreed date and time during normal business hours.
 4. Each training day shall not exceed 8 hours of training. Daily training schedule shall allow time for 1-hour lunch period and 15-minute break after every 2 hours of training.
 5. Perform not less than 16 total hours of training.
- D. Location: Owner shall provide a suitable on-site location to host classroom training.
- E. Training Attendees: Assume five (5) people. Verify with Owner at the time of scheduling training for actual number of attendees.
- F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.
- G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.
- H. Training Materials: Provide training materials in electronic format to each attendee.
1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.
- I. Acceptance: Obtain Owner written acceptance that training is complete, and requirements indicated have been satisfied.
- J. Provide video recordings of how the HVAC system equipment physically operates, etc.

END OF SECTION 238129

SECTION 238216 - AIR COILS

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 types of air coils that are not an integral part of air-handling units:
 - 1. Hot water.
 - 2. Electric.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.
- B. Shop Drawings: Diagram power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.
- B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 - 2. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 WATER COILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Coil Company, LLC
 - 2. Greenheck Industries
 - 3. Trane
 - 4. USA Coil & Air
- B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
- C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.
- D. Source Quality Control: Factory tested to 300 psig.
- E. Tubes: ASTM B 743 copper, minimum 0.035-inch-thick.
- F. Fins: Aluminum, minimum 0.006-inch-thick.
- G. Headers: Seamless copper tube with brazed joints, prime coated.
- H. Frames: Galvanized-steel channel frame, minimum 0.052-inch-thick for flanged mounting.
- I. Frames: ASTM A 666, Type 304 stainless-steel, minimum 0.0625-inch-thick for flanged mounting.
- J. Hot-Water Coil Capacities and Characteristics: Refer to Schedules on Drawings.

2.2 ELECTRIC COILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Chromalox, Inc., Wiegand Industrial Division; Emerson Electric Company
 - 2. Greenheck Industries
 - 3. INDEECO
- B. Coil Assembly: Comply with UL 1995.
- C. Heating Elements: Coiled resistance wire of eighty percent (80%) nickel and twenty percent (20%) chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
- D. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.
 - 1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- E. Frames: Galvanized-steel channel frame, minimum 0.052-inch-thick for flanged mounting.
- F. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:

1. Magnetic contactor.
 2. Fan interlock.
 3. Step controller.
 4. Time-delay relay.
 5. Pilot lights; one (1) per step.
 6. Airflow proving switch.
 7. Disconnect switch.
 8. Power fusing.
- G. Thermostats: Wall-mounted thermostats, with temperature range from 50 to 90 deg F, and 2.5 deg F throttling range.
- H. Capacities and Characteristics: Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Straighten bent fins on air coils.
- D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC," and other piping specialties are specified in Section 232113 "Hydronic Piping."
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 238216

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 078413 "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052-inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and one (1) or more sides equal to, or more than, 16 inches, thickness shall be 0.138-inch.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM and/or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless-steel. Include two (2) for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless-steel of length required to secure pressure plates to sealing elements. Include one (1) for each sealing element.

2.3 GROUT

- A. Non-metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, non-metallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide ½-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Section 078413 "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install them in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078413 "Penetration Firestopping."

3.5 COMISSIONING OF EQUIPMENT

- A. Engage a factory authorized service representative, who is familiar with this project, to participate and assist, if necessary, in the functional performance testing of the equipment included in this Division with the Commissioning Agent.

END OF SECTION 260500

SECTION 260509 - ELECTRICAL DEMOLITION REQUIREMENTS

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. Demolition involving electrical systems as described in Contract Documents.
- B. Related Sections:
 - 1. Section 260500 "Common Work Results for Electrical"
 - 2. New and replacement work specified in appropriate specification sections.

1.3 SCHEDULING

- A. Include on Construction Schedule sequence of individual electrical demolition operations.
- B. Coordinate with Owner for equipment and materials to be removed by Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. All relocations, reconnections, and removals are not necessarily indicated on Drawings. All such work shall be included without additional cost to the Owner.

3.2 PREPARATION

- A. Disconnect equipment that is to be removed or relocated. Carefully remove, disassemble, or dismantle as required, and store in approved location on site, existing items to be reused in completed work.
- B. Where affected by demolition or new construction, relocate, extend, or repair raceways, conductors, outlets, and apparatus to allow continued use of electrical system. Use methods and materials as specified for new construction.

3.3 PERFORMANCE

- A. Perform drilling, cutting, block-offs, and demolition work required for removal of necessary portions of electrical system. Do not cut joists, beams, girders, trusses, or columns without prior written permission from the Architect.

ELECTRICAL DEMOLITION REQUIREMENTS

- B. Remove concealed wiring abandoned due to demolition or new construction. Remove circuits, conduits and conductors that are not to be re-used back to next active fixture, device or junction box.
- C. Patch, repair, and finish surfaces affected by electrical demolition work, unless work is specifically called for under other Sections of the specifications.

3.4 CLEANING

- A. Remove obsolete raceways, conductors, apparatus, and lighting fixtures promptly from site and dispose of legally.

END OF SECTION 260509

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.
 - 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
 - 1. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division
 - 2. American Insulated Wire Corp.; a Leviton Company
 - 3. Belden
 - 4. General Cable Corporation
 - 5. Senator Wire & Cable Company
 - 6. Southwire Company
- B. Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.
- D. Multi-conductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC, mineral-insulated, and metal-sheathed cable, Type MI with ground wire.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) 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.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

- A. Comply with requirements of Section 260500 "Common Work Results for Electrical" for sleeves.

2.4 SLEEVE SEALS

- A. Comply with requirements of Section 260500 "Common Work Results for Electrical" for sleeve seals.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for all feeders including service entrance cables. 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. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway and metal-clad cable, Type MC.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway and metal-clad cable, Type MC.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- I. Branch Circuits Installed Below Raised Flooring: Type THHN-THWN, single conductors in raceway and metal-clad cable, Type MC.
- J. Branch Circuits in Cable Tray: Type THHN-THWN, single conductors in raceway and metal-clad cable, Type MC.
- K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- L. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- M. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited cable, concealed in building finishes, Power-limited tray cable, in cable tray.

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 Section 260529 "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.
- B. Wiring Method: Install wiring in metal pathway according to Section 270528 "Pathways for Communications Systems."
 - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
 - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
 - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
 - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted if approved by AHJ.
 - 4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one (1) riser does not prevent receipt or transmission of signals from other floors or zones.
- G. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install the number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A 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 un-spliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Comply with installation requirements of Section 260500 "Common Work Results for Electrical" for sleeves.

3.7 SLEEVE-SEAL INSTALLATION

- A. Comply with installation requirements of Section 260500 "Common Work Results for Electrical" for sleeve seals.

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each 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 sixty (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. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. 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.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER 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. Section Includes:
 - 1. UTP cabling.
 - 2. 50/125 and 62.5/125-micrometer, multi-mode optical fiber cabling.
 - 3. RS-232 cabling.
 - 4. RS-485 cabling.
 - 5. Low-voltage control cabling.
 - 6. Control-circuit conductors.
 - 7. Identification products.

1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.
- C. EMI: Electromagnetic interference.
- D. IDC: Insulation displacement connector.
- E. Ladder Cable Tray: A fabricated structure consisting of two (2) longitudinal side rails connected by individual transverse members (rungs).
- F. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- G. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- H. RCDD: Registered Communications Distribution Designer.
- I. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.
- J. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using seventy-five percent (75%) or less of the plan area of the surface to support cables.
- K. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - 1. Vertical and horizontal offsets and transitions.
 - 2. Clearances for access above and to side of cable trays.
 - 3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - 4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
- C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Maintenance Data: For wire and cable to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of a NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
 - 2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
 - 3. Test each pair of UTP cable for open and short circuits.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install UTP and optical fiber cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is

operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. Support of Open Cabling: NRTL labeled for support of Category 6A and Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
 - 2. Lacing bars, spools, J-hooks, and D-rings.
 - 3. Straps and other devices.
- B. Cable Trays:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Cable Management Solutions, Inc.
 - b. Cablofil Inc.
 - c. Cooper B-Line, Inc.
 - d. Cope - Tyco/Allied Tube & Conduit
 - e. GS Metals Corp.
 - 2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472-inch-thick hot-dip galvanizing, complying with ASTM A 123, Grade 0.55, not less than 0.002165-inch-thick.
 - a. Basket Cable Trays: Minimum 6 inches wide and 2 inches deep. Wire mesh spacing shall not exceed 2 by 4 inches.
 - b. Trough or Ventilated Cable Trays: Minimum nominally 6 inches wide.
 - c. Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches.
 - d. Channel Cable Trays: One-piece construction, nominally 4 inches wide. Slot spacing shall not exceed 4½ inches o.c.
 - e. Solid-Bottom or Non-ventilated Cable Trays: One-piece construction, nominally 12 inches wide. Provide with solid covers.
- C. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems". Flexible metal conduit shall not be used.
 - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2½ inches deep.

2.2 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Berk-Tek; a Nexans company
 - 2. CommScope, Inc.
 - 3. Mohawk; a division of Belden CDT
 - 4. Superior Essex Inc.

- B. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket unless color is otherwise specified in another section.
1. Comply with ICEA S-90-661 for mechanical properties.
 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 3. Comply with TIA/EIA-568-B.2, Category 6.
 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP complying with UL 1685.
 - b. Communications, Riser Rated: Type CMP or Type CMR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.3 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Hubbell Premise Wiring
 2. Leviton Voice & Data Division
 3. Orthotronics
 4. Panduit Corp.
- B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- C. Connecting Blocks: 110 style for Category 6. Provide blocks for the number of cables terminated on the block, plus twenty-five percent (25%) spare; integral with connector bodies, including plugs and jacks where indicated.

2.4 OPTICAL FIBER CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. ADC
 2. American Technology Systems Industries, Inc.
 3. Berk-Tek; a Nexans company
 4. Corning Cable Systems
 5. Dynacom Corporation
- B. Description: Unless modified by another section – Multi-mode, 50/125-micrometer, 12-fiber, non-conductive, tight buffer, optical fiber cable.
1. Comply with ICEA S-83-596 for mechanical properties.
 2. Comply with TIA/EIA-568-B.3 for performance specifications.
 3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - a. General Purpose, Non-conductive: Type OFN or OFNG.
 - b. Riser Rated, Non-conductive: Type OFNR, complying with UL 1666.
 5. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
7. Plenum Rated, Non-conductive: Type OFNP, complying with NFPA 262.

C. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.5 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Berk-Tek; a Nexans company
2. CommScope, Inc.
3. Corning Cable Systems
4. Dynacom Corporation
5. Siemon Co. (The)

B. Cable Connecting Hardware: Comply with the Fiber Optic Connector Interchangeability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

1. Quick-connect, simplex and duplex, Type SC, Type ST, Type LC, Type MT-RJ connectors. Insertion loss not more than 0.75 dB.
2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.6 RS-232 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two (2) pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with one hundred percent (100%) shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.7 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two (2) pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.8 LOW-VOLTAGE CONTROL CABLE

- A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 - 1. One (1) pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with NFPA 262.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 - 1. One (1) pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
 - 2. Fluorinated ethylene propylene insulation.
 - 3. Unshielded.
 - 4. Plastic jacket.
 - 5. Flame Resistance: NFPA 262, Flame Test.

2.9 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83 and/or UL 44.
- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, Type XHHN, in raceway, power-limited cable, concealed in building finishes, power-limited tray cable, in cable tray, complying with UL 83 and/or UL 44.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.10 FIRE-ALARM WIRE AND CABLE

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, no less than No. 16 AWG as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a 2-hour rating.
 - 1. Control-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 - 2. Low-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 - 3. Multi-conductor Armored Cable: NFPA 70, Type MC, copper conductors, Type THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

2.11 IDENTIFICATION PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Brady Corporation
2. HellermannTyton
3. Kroy LLC
4. Panduit Corp.

- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.12 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Factory test multi-mode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
- E. Cable will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
- B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- C. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- D. Install manufactured conduit sweeps and long-radius elbows if possible.
- E. Pathway Installation in Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
 2. Install cable trays to route cables if conduits cannot be located in these positions.
 3. Secure conduits to backboard if entering room from overhead.
 4. Extend conduits 3 inches above finished floor.
 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Do not untwist UTP cables more than ½-inch from the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors: Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceway and Boxes for Electrical Systems."

E. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

F. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

G. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 72 inches long shall be neatly coiled not less than 12 inches in diameter below each feed point.

H. Separation from EMI Sources:

CONTROL-VOLTAGE ELECTRICAL POWER CABLES

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in non-metallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2½ inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables.

3.4 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
 1. Class 1 remote-control and signal circuits, No 14 AWG.
 2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
 3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

- A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

- B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.

- a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

- a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- b. Link End-to-End Attenuation Tests:

- 1) Multi-mode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
- 2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

- C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 260523

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, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Foundation steel electrodes.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Ground rods.
 - 2. Grounding for sensitive electronic equipment.
- C. Qualification Data: For qualified testing agency and testing agency's field supervisor.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS and NFPA 70B.
 - a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or a 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, ¼-inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16-inch-thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16-inch-thick.
- C. Grounding Bus: Pre-drilled rectangular bars of annealed copper, ¼ by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches 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 (2) 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 and exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad, sectional type; ¾ inch in diameter by 10 feet.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with non-hazardous electrolytic chemical salts.
 - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
 - 2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install a 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 (3) bands of green and two (2) bands of yellow.
- C. Grounding Bus: Install in electrical and network equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. 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. Metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a non-metallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ¼-by-4-by-12-inch grounding bus.
 - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

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. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three (3) rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. 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.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one

- (1) of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four (4) locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.4 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
1. Manufacturer's Field Service: Contractor shall engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. 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.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

- a. Measure ground resistance no fewer than two (2) full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. 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.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
- F. 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. Section 260548 "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 (5) times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Non-metallic slotted support systems.
 - 3. Associated hardware.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. 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. Non-metallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.

- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
- B. 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. Non-metallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Non-metallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least one (1) surface.
 - 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. Fabco Plastics Wholesale Limited

- d. Seasafe, Inc.
 - 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless-steel.
 - 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. The body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. 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 and stainless-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.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems 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 scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be ¼-inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least twenty-five percent (25%) in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1½-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. 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. The minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To New Concrete: Bolt to concrete inserts.
 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

3. To Existing Concrete: Expansion anchor fasteners.
 4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 5. To Steel: Welded threaded studs complying with AWS D1.1, with lock washers and nuts, Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, Spring-tension clamps.
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Non-structural 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. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

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.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Section 078413 "Penetration Firestopping" specifies firestopping referenced by this Section.
 - 2. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies non-metallic underground conduit with conductors (Type NUCC).
 - 3. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
 - 4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.
 - 5. Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings" specifies additional requirements for installation of conduits for communications cabling.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical non-metallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible non-metallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RMC: Rigid metal conduit.
- J. RNC: Rigid non-metallic conduit.
- K. PVC: Schedule 40 or 80 rigid PVC conduit.

1.4 SUBMITTALS

- A. Product Data: For conduit, surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
 - 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members in the paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
- D. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Qualification Data: For professional engineer and testing agency.
- F. Source quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 4. Anamet Electrical, Inc.; Anaconda Metal Hose
 - 5. Electri-Flex Co.
 - 6. Manhattan/CDT/Cole-Flex
 - 7. Maverick Tube Corporation
 - 8. O-Z Gedney; a unit of General Signal
 - 9. Wheatland Tube Company
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit and IMC.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040-inch, minimum.
- F. EMT: ANSI C80.3.
- G. FMC: Zinc-coated steel or aluminum.
- H. LFMC: Flexible steel conduit with PVC jacket.
- I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Steel or die-cast and set-screw or compression type.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040-inch, with overlapping sleeves protecting threaded joints.
- J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NON-METALLIC CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose
 - 3. Arnco Corporation

4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products
10. Manhattan/CDT/Cole-Flex
11. RACO; a Hubbell Company
12. Thomas & Betts Corporation

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Arnco Corporation
2. Endot Industries Inc.
3. IPEX Inc.
4. Lamson & Sessions; Carlon Electrical Products

B. Description: Comply with UL 2024; flexible type, approved for plenum, riser, general-use installation.

2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cooper B-Line, Inc.
2. Hoffman
3. Square D; Schneider Electric

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type, Screw-cover type, Flanged-and-gasketed type, or as indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 NON-METALLIC WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Hoffman
 - 2. Lamson & Sessions; Carlon Electrical Products
- B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.6 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect and Owner.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Thomas & Betts Corporation
 - b. Walker Systems, Inc.; Wiremold Company (The)
 - c. Wiremold Company (The); Electrical Sales Division
- B. Surface Non-metallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect and Owner from manufacturer's entire range.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Butler Manufacturing Company; Walker Division
 - b. Enduro Systems, Inc.; Composite Products Division
 - c. Hubbell Incorporated; Wiring Device-Kellems Division
 - d. Lamson & Sessions; Carlon Electrical Products
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The)
 - g. Wiremold Company (The); Electrical Sales Division

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric
 - 3. Erickson Electrical Equipment Company
 - 4. Hoffman
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division
 - 6. O-Z/Gedney; a unit of General Signal
 - 7. RACO; a Hubbell Company

8. Robroy Industries, Inc.; Enclosure Division
9. Scott Fetzer Co.; Adalet Division
10. Spring City Electrical Manufacturing Company
11. Thomas & Betts Corporation
12. Walker Systems, Inc.; Wiremold Company (The)
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary

- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, cast ferrous alloy, Type FD, with gasketed cover.
- D. Non-metallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast iron or sheet metal, fully adjustable, rectangular.
- F. Non-metallic Floor Boxes: Non-adjustable, round.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized cast iron with gasketed cover.
- I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Non-metallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- J. 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.

2.8 SLEEVES FOR RACEWAYS

- A. Comply with requirements in Section 260500 "Common Work Results for Electrical" for sleeves.

2.9 SLEEVE SEALS

- A. Comply with requirements in Section 260500 "Common Work Results for Electrical" for sleeve seals.

2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit, IMC, RNC, Type EPC-40-PVC, RNC, Type EPC-80-PVC.
2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, RNC, Type EPC-40-PVC, RNC, Type EPC-80-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried unless indicated otherwise.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
6. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Polymer concrete enclosures with polymer-concrete frame and cover, SCTE 77, Tier 15 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
 - c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT, Surface metal raceway, surface non-metallic raceway (where specifically noted).
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Auto shop.
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: Rigid steel conduit.
7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway, EMT.
8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway, EMT.
9. Raceways for Concealed General-Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable raceway, Riser-

- type, optical fiber/communications cable raceway, Plenum-type, optical fiber/communications cable raceway, EMT.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless-steel or non-metallic in damp or wet locations.
- C. Minimum Raceway Size: ¾-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
- E. Install non-ferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in non-metallic sleeve.
- F. Do not install aluminum conduits in contact with concrete.
- 3.2 INSTALLATION
- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches 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. Support raceways as specified in Section 260529 "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three (3) 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Change from RNC, Type EPC-40-PVC, to rigid steel conduit, or IMC before rising above the floor.
- I. 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.

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and non-metallic, rigid and flexible, as follows:
 - 1. ¾-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two (2) 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
 - 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - 2. Install fitting(s) that provide expansion and contraction for at least 0.00041-inch per foot of length of straight run per deg F of temperature change.
 - 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- O. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- P. 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.
- Q. Set metal floor boxes level and flush with finished floor surface.

- R. Set non-metallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Comply with requirements in Section 260500 "Common Work Results for Electrical" for sleeves.

3.4 SLEEVE-SEAL INSTALLATION

- A. Comply with requirements in Section 260500 "Common Work Results for Electrical" for sleeve seals.

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 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

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. Isolation pads.
 - 2. Spring isolators.
 - 3. Restrained spring isolators.
 - 4. Channel support systems.
 - 5. Restraint cables.
 - 6. Hanger rod stiffeners.
 - 7. Anchorage bushings and washers.
- B. Related Sections include the following:
 - 1. Section 260529 "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. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
 - a. Component Importance Factor: 1.5.
 - b. Component Response Modification Factor: 5.5.
 - c. Component Amplification Factor: 1.0.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second).

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. 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.
 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- B. Delegated-Design Submittal: For vibration isolation and 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.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.
 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. Indicate association with vibration isolation devices.
 - c. Pre-approval 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 professional engineer and 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, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approval OPA number from OSHPD, pre-approval by ICC-ES, or pre-approval 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 pre-approved 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 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Ace Mountings Co., Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. California Dynamics Corporation
 - 4. Isolation Technology, Inc.
 - 5. Kinetics Noise Control
 - 6. Mason Industries
 - 7. Vibration Eliminator Co., Inc.
 - 8. Vibration Isolation
 - 9. Vibration Mountings & Controls, Inc.
- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
 - 3. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
 - 4. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to ¼-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to ¼-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
4. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
5. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
6. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of 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 (4) 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 (2) 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 (8) 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.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be 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 vibration isolation and 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. 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 pre-stressed 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, wireways, cable trays, and busways 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. Perform tests and inspections.
- B. 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 post connection testing has been approved), and with at least seven (7) days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four (4) of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to ninety percent (90%) 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.

C. Remove and replace malfunctioning units and retest as specified above.

D. 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. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 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. Colors for Raceways Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.
- D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Pre-printed, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, pre-printed, 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 for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch-wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.
- H. Metal Tags: Brass or aluminum, 2-by-2-by-0.05-inch, with stamped legend, punched for use with self-locking cable tie fastener.
- I. Write-On Tags: Polyester tag, 0.015-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 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. Colors for Raceways Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.
- D. Self-Adhesive Vinyl Labels: Pre-printed, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

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: Pre-printed, 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, with stamped legend, punched for use with self-locking cable tie fastener.
- D. Write-On Tags: Polyester tag, 0.015-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- E. Snap-Around Labels: Slit, pre-tensioned, flexible, pre-printed, 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, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches 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 thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Pre-printed, 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, pre-tensioned, flexible, pre-printed, 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, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches 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, 0.015-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 FLOOR MARKING TAPE

- A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
- B. Furnish and install tape at location in accordance with NEC 110.26 for all electrical distribution equipment.

2.6 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
- C. Tag: Type ID:
 - 1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one (1) side with the inscription of the utility, compounded for direct-burial service.
 - 2. Overall Thickness: 5 mils.
 - 3. Foil Core Thickness: 0.35 mil.
 - 4. Weight: 28 lb./1000 sq. ft.
 - 5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.7 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.

- B. Self-Adhesive Warning Labels: Factory-printed, multi-color, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 - 1. Pre-printed aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. ¼-inch grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, non-fading, pre-printed, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. ¼-inch grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.8 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16-inch-thick for signs up to 20 sq. inches and 1/8-inch-thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch.
- C. 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. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 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.
- 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. 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.

- 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.
- E. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1-inch.

2.10 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16-inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black except where used for color-coding.
- B. 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.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one-piece, self-locking.
 - 1. Minimum Width: 3/16-inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.11 DATA RECEPTACLES

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. It should read "DATA ONLY". Minimum letter height shall be 3/8-inch.
- 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. 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.

2.12 RECEPTACLES ON EMERGENCY POWER

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in orange, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch. Overlay shall provide a weatherproof and UV-resistant seal for label. Install orange label with receptacle device for identification.

2.13 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. 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 maximum intervals in straight runs, and at 25-foot 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. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.2 IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at 30-foot maximum intervals.

- C. 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 30-foot maximum intervals.
- D. 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.
 - 2. Standby Power.
 - 3. Normal Power.
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, 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 service, feeder, and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 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 from terminal points and in boxes where splices or taps are made. Apply last two (2) turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- F. Power-Circuit Conductor Identification, more than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags, non-metallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- G. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- H. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- I. 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.

- J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Limit use of underground-line warning tape to direct-buried cables.
 - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- K. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- M. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- N. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer and load shedding.
- O. 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. Unless otherwise indicated, provide a single line of text with ½-inch-high letters on 1½-inch-high label; where two (2) lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label. Stenciled legend 4 inches high.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. 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: Type written directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive and engraved laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchgear.
- e. Switchboards.
- f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- g. Emergency system boxes and enclosures.
- h. Enclosed switches.
- i. Enclosed circuit breakers.
- j. Enclosed controllers.
- k. Variable-speed controllers.
- l. Push-button stations.
- m. Power transfer equipment.
- n. Contactors.
- o. Remote-controlled switches, dimmer modules, and control devices.
- p. Power-generating units.
- q. Monitoring and control equipment.
- r. UPS equipment.

END OF SECTION 260553

SECTION 260572 - OVERCURRENT PROTECTIVE SHORT-CIRCUIT STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices (for new panels and transformers only).

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- G. SCCR: Short-circuit current rating.
- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. For computer software program to be used for studies.
 - 2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

- a. Short-circuit study input data, including completed computer program input data sheets.
- b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - 1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
 - 2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

- 1. For Power Systems Analysis Software Developer.
- 2. For Power System Analysis Specialist.
- 3. For Field Adjusting Agency.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

- 1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
- 2. The following are from the Short-Circuit Study Report:
 - a. Final one-line diagram.
 - b. Final Short-Circuit Study Report.
 - c. Short-circuit study data files.
 - d. Power system data.

1.7 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
 - 1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

- D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- F. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Comply with IEEE 399 and IEEE 551.
 - 1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - 6. Derating factors and environmental conditions.
 - 7. Any revisions to electrical equipment required by the study.
- D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.

3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated $\frac{1}{2}$ -cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to $\frac{1}{2}$ -cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated $\frac{1}{2}$ -cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
 - 1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
 - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
- B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
 - 1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance at the service.
 - 3. Power sources and ties.
 - 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - 5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 - 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 - 7. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 - 8. Motor horsepower and NEMA MG 1 code letter designation.
 - 9. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or non-magnetic).
 - 10. Derating factors.

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- I. Include in the report identification of any protective device applied outside its capacity.
- J. Study is required for new equipment and panelboards. Where the main equipment feeds downstream distribution that is existing to remain, the study is only required to extend to the first existing device in a string.

END OF SECTION 260572

SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals may be in digital form.
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Arc-Flash Study Specialist.

- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
- B. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and 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.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers: Subject to compliance with requirements, provide software by one (1) of the following:
 - 1. ESA Inc.
 - 2. Operation Technology, Inc.
 - 3. Power Analytics, Corporation
 - 4. SKM Systems Analysis, Inc.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Fault-Current Study" Paragraph in "Overcurrent Protective Device Coordination Study" Article in Section 260572 "Overcurrent Protective Device Coordination Study."
- F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Coordination Study."
- G. Arc-Flash Study Output:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Working distance.
 - 6. Incident energy.
 - 7. Hazard risk category.
 - 8. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1. Location designation.
 - 2. Nominal voltage.
 - 3. Flash protection boundary.
 - 4. Hazard risk category.
 - 5. Incident energy.
 - 6. Working distance.
 - 7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Study and labeling are required for all distribution equipment, whether new or existing to remain.
- C. Preparatory Studies:
 - 1. Short-Circuit Study Output: As specified in "Fault-Current Study" Paragraph in "Overcurrent Protective Device Coordination Study" Article in Section 260572 "Overcurrent Protective Device Coordination Study."
 - 2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Coordination Study."
- D. Calculate maximum and minimum contributions of fault-current size.
 - 1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
 - 2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- E. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- F. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.

- G. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- H. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond three to five (3-5) cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from ten (10) per unit to three (3) per unit after ten (10) cycles).
- I. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- J. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Architect.
 - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance at the service.
 - 3. Power sources and ties.
 - 4. Short-circuit current at each system bus, three phase and line-to-ground.
 - 5. Full-load current of all loads.
 - 6. Voltage level at each bus.
 - 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.

8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or non-magnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.4 LABELING

- A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
 1. Low-voltage switchboard.
 2. Switchgear.
 3. Medium-voltage switch.
 4. Control panel.

3.5 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

- A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 260574

SECTION 260800– COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
- B. The OPR and BOD documentation are required from the EOR to be included by reference to the Cx.

1.2 SUMMARY

- A. This section includes commissioning process requirements for Electrical systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Section 26 / 0500 / 0519 / 0923 / 3100 – Electrical
 - 2. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "General Commissioning Requirements" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "General Commissioning Requirements" for Cx's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements. In addition, provide the following:
- C. In addition, provide the following:
 - 1. Certificates of readiness
 - 2. Certificates of completion of installation, prestart, and startup activities.
 - 3. O&M manuals
 - 4. Test reports

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to Cx upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the electrical contractor of Division 26 shall ultimately be responsible for all standard testing equipment for the electrical systems and controls systems in Division 26. A sufficient quantity of two-way radios shall be provided by each subcontractor along with any lifts or ladders.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the Cx.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturers shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. Data logging equipment and software required to test equipment will be provided by the Cx but shall not become the property of the Owner.
- E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. Red-lined Drawings:
 - 1. The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.

2. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.
4. The contracted party, as defined in the Contract Documents will create the as-built drawings.

B. Operation and Maintenance Data:

1. Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
2. The Cx will review the O&M literature once for conformance to project requirements.
3. The Cx will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.

C. Demonstration and Training:

1. Contractor will provide demonstration and training as required by the specifications.
2. A complete training plan and schedule must be submitted by the contractor to the Cx four weeks (4) prior to any training.
3. A training agenda for each training session must be submitted to the Cx two (2) weeks prior the training session.
4. The Cx shall be notified at least 72 hours in advance of scheduled tests so that testing may be observed by the Cx and Owner's representative. A copy of the test record shall be provided to the Cx, Owner, and Architect.
5. Engage a Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.
6. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment.
7. Review data in O&M Manuals.

D. Systems manual requirements:

1. The Systems Manual if required is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
2. The Contractor shall include final approved versions of the following information for the Systems Manual:
 - a. As-Built System Schematics
 - b. Verified Record Drawings
 - c. Test Results (not otherwise included in Cx Record)
 - d. Periodic Maintenance Information for computer maintenance management system
 - e. Recommendations for recalibration frequency of sensors and actuators
 - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - g. Training Records, Information on training provided, attendees list, and any on-going training
3. This information shall be organized and arranged by building system, such as fire alarm, heat pumps, heating hot water, etc.
4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the Cx.
- B. Attend construction phase controls coordination meetings.
- C. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the Cx.
- D. Provide information requested by the Cx for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Electrical system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner. Distribute preliminary schedule to commissioning team members.
- G. Update schedule as required throughout the construction period.
- H. During the startup and initial checkout process, execute the related portions of the prefunctional checklists for all commissioned equipment.
- I. Assist the Cx in all verification and functional performance tests.
- J. Provide measuring instruments and logging devices to record test data and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- K. Gather operation and maintenance literature on all equipment and assemble in binders as required by the specifications.
- L. Coordinate with the Cx to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- M. Notify the Cx a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.
- N. Participate in, and schedule vendors and contractors to participate in the training sessions.
- O. Provide written notification to the CM and Cx that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
 - 1. Electrical equipment including switchgear, panel boards, motor control centers, lighting, receptacles, dimmers and all other equipment furnished under this Division.
 - 2. Fire alarm system (Witness Only)
 - 3. Lighting Control
 - 4. Emergency Lighting
- P. The equipment supplier shall document the performance of his equipment.
- Q. Provide a complete set of red-lined drawings to the Cx prior to the start of Functional Performance Testing.

R. Provide training of the Owner's operating staff using expert qualified personnel, as specified.

S. Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
2. Assist in equipment testing per agreements with contractors.
3. Provide information requested by Cx regarding equipment sequence of operation and testing procedures.

T. Refer to Division 01 Section "General Commissioning Requirements" for additional Contractor responsibilities.

3.3 OWNER'S RESPONSIBILITIES

A. Refer to Division 01 Section "General Commissioning Requirements" for Owner's Responsibilities.

3.4 DESIGN PROFESSIONAL'S RESPONSIBILITIES

A. Refer to Division 01 Section "General Commissioning Requirements" for Design Professional's Responsibilities.

3.5 Cx'S RESPONSIBILITIES

A. Refer to Division 01 Section "General Commissioning Requirements" for Cx's Responsibilities.

3.6 TESTING PREPARATION

- A. Certify in writing to the Cx that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the Cx that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the Cx.

3.7 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the Cx.
- B. Scope of Electrical testing shall include the entire Electrical installation, from the incoming power equipment throughout the distribution system. Testing shall include measuring, but not limited to resistance, voltage, and amperage of system(s) and devices.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The Cx along with the Electrical contractor and other contracted subcontractors, including the fire alarm Subcontractor shall prepare detailed testing plans, procedures, and checklists for Electrical systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the Cx and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The Cx may direct that set points be altered when simulating conditions is not practical.
- H. The Cx may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.8 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 26 sections. Provide submittals, test data, inspector record, infrared camera and certifications to the Cx.
- B. Emergency Generator Testing and Acceptance Procedures: Provide technicians, load banks, infrared cameras, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the Cx. The Cx shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- C. Electrical Distribution System Testing: Provide technicians, load banks, infrared cameras, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the Cx. The Cx shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested

- D. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated
1. Lighting (Integration with BMS)
 2. Electrical Distribution Systems (oversight)
 3. Occupancy Sensors (20% sampling)
 4. Daylighting controls (20% sampling)
 5. Building Fire Alarm System (Witness JHA Inspection)

3.9 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.10 APPROVAL

- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.

3.11 DEFERRED TESTING

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.

3.12 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section "General Commissioning Requirements" for the AE and Cx roles in the Operation and Maintenance Manual contribution, review and approval process.

3.13 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to training.
- B. Electrical Contractor. The electrical contractor shall have the following training responsibilities:
1. Provide the CA with a training plan two (2) weeks before the planned training.
 2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
 3. Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation.
 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece

- of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 7. Training shall include:
 - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Cover common troubleshooting problems and solutions.
 - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
 8. Hands-on training shall include start-up, operation in all possible modes, including manual, shut-down and any emergency procedures and preventative maintenance of all pieces of equipment.
 9. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
 10. Training shall occur after functional testing is complete, unless approved otherwise by the Owner or Owners Representative.

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Outdoor and indoor photoelectric switches.
 - 3. Standalone daylight-harvesting switching and dimming controls.
 - 4. Indoor occupancy sensors.
 - 5. Switchbox-mounted occupancy sensors.
 - 6. Outdoor motion sensors.
 - 7. Lighting contactors.
 - 8. Emergency shunt relays.
- B. Related Sections include the following:
 - 1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:
1. Area Lighting Research, Inc.; Tyco Electronics
 2. Grasslin Controls Corporation; a GE Industrial Systems Company
 3. Intermatic, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lightolier Controls; a Genlyte Company
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. Paragon Electric Co.; Invensys Climate Controls
 8. Square D; Schneider Electric
 9. TORK
 10. Touch-Plate, Inc.
 11. Watt Stopper (The)
- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
1. Contact Configuration: SPST, DPST, and DPDT.
 2. Contact Rating: 30-A inductive or resistive, 240-V ac, and 20-A ballast load, 120/240-V ac.
 3. Program: On-off set points per manufacturer's standards, confirm with Owner.
 4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
 5. Astronomic Time: All channels.
 6. Battery Backup: For schedules and time clock.
- C. Electromechanical-Dial Time Switches: Type complying with UL 917.
1. Contact Configuration: SPST, DPST, SPDT, and DPDT.
 2. Contact Rating: 30-A inductive or resistive, 240-V ac, 20-A ballast load, 120/240-V ac.
 3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 4. Astronomic time dial.
 5. Eight-Day Program: Uniquely programmable for each weekday and holidays.
 6. Skip-a-day mode.
 7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:

1. Area Lighting Research, Inc.; Tyco Electronics
 2. Grasslin Controls Corporation; a GE Industrial Systems Company
 3. Intermatic, Inc.
 4. Lithonia Lighting; Acuity Lighting Group, Inc.
 5. Novitas, Inc.
 6. Paragon Electric Co.; Invensys Climate Controls
 7. Square D; Schneider Electric
 8. TORK
 9. Touch-Plate, Inc.
 10. Watt Stopper (The)
- B. Description: Solid state, with SPST and DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
 2. Time Delay: 15-second minimum, to prevent false operation.
 3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
- C. Description: Solid state, with SPST and DPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.
1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 2. Time Delay: 30-second minimum, to prevent false operation.
 3. Lightning Arrester: Air-gap type.
 4. Mounting: Twist lock complying with IEEE C136.10, with base.

2.3 INDOOR PHOTOELECTRIC SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:
1. Allen-Bradley/Rockwell Automation
 2. Area Lighting Research, Inc.; Tyco Electronics
 3. Eaton Electrical Inc; Cutler-Hammer Products
 4. Grasslin Controls Corporation; a GE Industrial Systems Company
 5. Intermatic, Inc.
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. MicroLite Lighting Control Systems
 8. Novitas, Inc.
 9. Paragon Electric Co.; Invensys Climate Controls
 10. Square D; Schneider Electric
 11. TORK
 12. Touch-Plate, Inc.
 13. Watt Stopper (The)
- B. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit mounted on luminaire, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
3. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two (1) LEDs to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:
 1. Bryant Electric
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation
 4. Intermatic, Inc.
 5. Leviton Manufacturing Company
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. Lutron Electronics Co., Inc.
 8. NSi Industries LLC
 9. Philips Lighting Controls
 10. Sensor Switch, Inc.
 11. Square D; Schneider Electric
 12. Watt Stopper; a Legrand
- B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 1. Lighting control set point is based on two (2) lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with two (2) hand-held, remote-control tools.
 - a. Initial setup tool.
- C. Tool for occupants to adjust the target levels by increasing the set point up to twenty-five percent (25%), or by minimizing the electric lighting level
- D. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated power pack, to detect changes in indoor lighting levels that are perceived by the eye.
- E. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

2.5 INDOOR OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:
1. Hubbell Lighting
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. Novitas, Inc.
 5. RAB Lighting, Inc.
 6. Sensor Switch, Inc.
 7. TORK
 8. Watt Stopper (The)
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a ½-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
- C. PIR Type: Ceiling mounting; detect occupancy by sensing heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.
- D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch-high ceiling.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot-high ceiling in a corridor not wider than 14 feet.
- E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.6 OUTDOOR MOTION SENSORS (PIR)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:
1. Bryant Electric; a Hubbell Company
 2. Hubbell Lighting
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. Paragon Electric Co.; Invensys Climate Controls
 5. RAB Lighting, Inc.
 6. TORK
 7. Watt Stopper (The)
- B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as raintight according to UL 773A.
1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
 - b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 3. Bypass Switch: Override the on function in case of sensor failure.
 4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.
- C. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
- D. Detection Coverage: Up to 35 feet, with a field of view of 90 degrees.

- E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.
- F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 - 2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.7 LIGHTING CONTACTORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:
 - 1. Allen-Bradley/Rockwell Automation
 - 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 - 3. Eaton Electrical Inc.; Cutler-Hammer Products
 - 4. GE Industrial Systems; Total Lighting Control
 - 5. Grasslin Controls Corporation; a GE Industrial Systems Company
 - 6. Hubbell Lighting
 - 7. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 8. MicroLite Lighting Control Systems
 - 9. Square D; Schneider Electric
 - 10. TORK
 - 11. Touch-Plate, Inc.
 - 12. Watt Stopper (The)
- B. Description: Electrically operated and electrically held, combination type with non-fused disconnect, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with fifteen percent (15%) or less total harmonic distortion of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250.
 - 4. Provide with control and pilot devices as indicated on Drawings and schedule, matching the NEMA type specified for the enclosure.
- C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
 - 1. Monitoring: On-off status.
 - 2. Control: On-off operation.

2.8 EMERGENCY SHUNT RELAY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:
 - 1. LVS, Inc.
 - 2. Sensor Switch

3. Watt Stopper

- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts (dual-contact where required); complying with UL 924.

1. Coil Rating: 120-277 V or as indicated on Drawings.

2.9 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than ninety percent (90%) coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be ½-inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device and adjust time delays.

- B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 260923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

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 types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Buck-boost transformers.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.
- D. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

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. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. ACME Electric Corporation; Power Distribution Products Division
 - 2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.

3. Eaton Electrical Inc.; Cutler-Hammer Products
4. General Electric Company
5. Myers Power Products, Inc.
6. Siemens Energy & Automation, Inc.
7. Square D; Schneider Electric

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Cores: One (1) leg per phase.
- D. Enclosure: Ventilated, NEMA 250, Type 2.
 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
 1. Finish Color: Gray.
- F. Taps for Transformers Smaller Than 3 kVA: None.
- G. Taps for Transformers 7.5 to 24 kVA: One (1) five percent (5%) tap above and one (1) five percent (5%) tap below normal full capacity.
- H. Taps for Transformers 25 kVA and Larger: Two (2) two one one-half percent (2.5%) taps above and two (2) two and one-half percent (2.5%) taps below normal full capacity.
- I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 2. Tested according to NEMA TP 2.
- K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 2. Indicate value of K-factor on transformer nameplate.
- L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 2. Include special terminal for grounding the shield.
 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- M. Wall Brackets: Manufacturer's standard brackets.
- N. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- O. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
- P. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
1. 9 kVA and Less: 40 dBA.
 2. 30 to 50 kVA: 45 dBA.
 3. 51 to 150 kVA: 50 dBA.

2.4 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
1. Finish Color: Gray.

2.5 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.

- D. Infrared Scanning: Two (2) months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform two (2) follow-up infrared scans of transformers, one (1) at four (4) months and the other at eleven (11) months after Substantial Completion.
 - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus ten percent (+10%) and not being lower than nameplate voltage minus three percent (-3%) at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus five percent (+/-5%), at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 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 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
 - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. 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.
- F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

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. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards 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 NEMA PB 1.
- F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: 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 Architect and Construction Manager Owner no fewer than two (2) days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without the Architect's and Construction Manager's written permission.
 - 3. Comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five (5) years from date of Substantial Completion.

1.11 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two (2) spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two (2) spares for each panelboard.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 5 or Type 12.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pre-treating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
 - 7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, ninety-eight percent (98%) conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, ninety-eight percent (98%) conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one (1) or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two (2) latches, keyed alike.

D. Mains: Circuit breaker, Fused switch, and Lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
- G. Contactors in Main Bus: NEMA ICS 2, Class A, electrically and/or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. External Control-Power Source: 120-V branch circuit.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically and/or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. External Control-Power Source: 120-V branch circuit.
- F. Doors: Concealed hinges; Door-in-door style, secured with flush latch with tumbler lock; keyed alike.
- G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Electronic trip setting for circuit-breaker frame sizes 200 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression and Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120 and/or 24 V trip coil energized from separate circuit, set to trip at seventy-five percent (75%) of rated voltage.
 - f. Undervoltage Trip: Set to operate at thirty-five to seventy-five percent (35-75%) of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - g. Auxiliary Contacts: One (1) SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - j. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - k. Multi-pole units enclosed in a single housing or factory assembled to operate as a single unit.
 - l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
 2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

3. Auxiliary Contacts: One (1) normally open and normally closed contact(s) that operate with switch handle operation.

2.5 PANELBOARD SUPPRESSORS (WHEN INDICATED ON DRAWINGS)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 1. Current Technology; a subsidiary of Danahar Corporation
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution
 4. Liebert Corporation
 5. Siemens Energy & Automation, Inc.
 6. Square D; a brand of Schneider Electric
- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
 1. Accessories:
 - a. LED indicator lights for power and protection status.
 - b. Audible alarm, with silencing switch, to indicate when protection has failed.
 - c. One (1) set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407 and/or NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407 and/or NEMA PB 1.1.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

- C. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four (4) 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four (4) 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- J. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

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 panelboard bus, 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 sixty (60) days after Final Acceptance, perform an infrared scan of each panelboard. 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 panelboard eleven (11) months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included 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 component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260572 "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, measure load balancing and make circuit changes.
 1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding twenty percent (20%) between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Receptacles with integral surge suppression units.
 - 4. Wall-box motion sensors.
 - 5. Isolated-ground receptacles.
 - 6. Snap switches and wall-box dimmers.
 - 7. Solid-state fan speed controls.
 - 8. Wall-switch and exterior occupancy sensors.
 - 9. Communications outlets.
 - 10. Pendant cord-connector devices.
 - 11. Cord and plug sets.
 - 12. Floor service outlets, poke-through assemblies, service poles, and multi-outlet assemblies.
 - 13. EPO mushroom switches
- B. Related Sections include the following:
 - 1. Section 271500 "Communications Horizontal Cabling" for workstation outlets.

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. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

- C. Samples: One (1) for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one (1) source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one (1) source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. 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. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 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; **5351** (single), **5352** (duplex)
 - b. Hubbell; **HBL5351** (single), **CR5352** (duplex)
 - c. Leviton; **5891** (single), **5352** (duplex)
 - d. Pass & Seymour; **5381** (single), **5352** (duplex)
- B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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. Hubbell; **CR 5253IG**
 - b. Leviton; **5362-IG**
 - c. Pass & Seymour; **IG6300**
 2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
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. Duplex GFCI Convenience Receptacles, 125 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; **GF20**
 - b. Pass & Seymour; **2084**

2.4 TVSS RECEPTACLES

- A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.
1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
 2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
- B. Duplex TVSS Convenience Receptacles:
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; **5362BLS**
 - b. Hubbell; **HBL5362SA**
 - c. Leviton; **5380**

2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

C. Isolated-Ground, Duplex Convenience Receptacles:

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; **IG5362BLS**
 - b. Hubbell; **IG5362SA**
 - c. Leviton; **5380-IG**
2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. 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; **L520R**
 - b. Hubbell; **HBL2310**
 - c. Leviton; **2310**
 - d. Pass & Seymour; **L520-R**
2. Refer to floor plans for other configurations required for project.

B. Isolated-Ground, Single Convenience Receptacles, 125 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. Hubbell; **IG2310**
 - b. Leviton; **2310-IG**
2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.7 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of thirty percent (30%).
 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 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."
- D. Key-Operated 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; **2221L**
 - b. Hubbell; **HBL1221L**
 - c. Leviton; **1221-2L**
 - d. Pass & Seymour; **PS20AC1-L**
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

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; **1995**
- b. Hubbell; **HBL1557**
- c. Leviton; **1257**
- d. Pass & Seymour; **1251**

- F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. 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; **1995L**
- b. Hubbell; **HBL1557L**
- c. Leviton; **1257L**
- d. Pass & Seymour; **1251L**

2.9 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. LED Lamp Dimmer Switches: Modular; compatible with LED lamps and driver; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end greater than twenty percent (20%) of full brightness.

2.10 FAN SPEED CONTROLS

- A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.
 1. Continuously adjustable rotary knob, 5 A.
 2. Three-speed adjustable slider, 1.5 A.

2.11 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:

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; **OSD10N**
- b. Hubbell; **AD2000W1**
- c. Leviton; **OS SMT-MDW**
- d. Pass & Seymour; **DW-100**
- e. Watt Stopper (The); **DW-100**

2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.

B. Long-Range Wall-Switch Sensors:

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. Hubbell; **ATD1600WRP**
 - b. Leviton; **ODW12-MRW**
 - c. Watt Stopper (The); **DT-200**
2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.

C. Wide-Range Wall-Switch Sensors:

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. Hubbell; **ATP120HBRP**
 - b. Leviton; **ODWHB-IRW**
 - c. Pass & Seymour; **HS1001**
 - d. Watt Stopper (The); **CX-100-3**
2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.

D. Exterior Occupancy Sensors:

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. Leviton; **PS200-10**
 - b. Watt Stopper (The); **EW-100-120**
2. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.12 COMMUNICATIONS OUTLETS

- A. Refer to Division 27 sections.

2.13 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Stainless, tamper resistant with trident pan head matching current building standard.
2. Material for Finished Spaces: Brushed stainless.
3. Material for Unfinished Spaces: Brushed stainless for flush box installations, raised galvanized for surface box installations.

- 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet locations while in use.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, thermoplastic with lockable cover.

2.14 MULTI-OUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems
 - 2. Wiremold Company (The)
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: No. 12 AWG.

2.15 EPO MUSHROOM SWITCHES

- A. Pushbuttons: NEMA ICS 2; Heavy-duty, oil-tight and dust-tight without boot, chrome-plated bezel, EMERG. STOP in front cover, red mushroom style actuator.
- B. Contact Blocks: Stacked mounting with single screw installation, color coded with clear window for contact status. Furnish with two (2) N.O. and two (2) N.C. contacts.
- C. Activation: Two-position, push to activate, key to return to normal state.
- D. Cover: Clear stopper shield with integral alarm and red label with lettering "EMERG. STOP".

2.16 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: Ivory and/or as selected by Architect and Owner from manufacturer's entire range, unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. TVSS Devices: Blue.
 - 4. Isolated-Ground Receptacles: Orange and/or as specified above, with orange triangle on face.

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 ensure 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. Pig tailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, $\frac{2}{3}$ to $\frac{3}{4}$ 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.
10. Install GFCI devices in all wet locations.

E. Receptacle Orientation: Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

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, multi-gang wall plates.
 - I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
 - J. EPO Switches: Pressing the EPO switch shall immediately shut down the designated loads by activating the assigned shunt trip or contactor device(s). As part of the EPO circuit, an interface shall also be provided for connecting one (1) or more normally open or normally closed remote EPO switches to the EPO circuit. Reset shall be by key operation.
- 3.2 IDENTIFICATION
- A. Comply with Section 260553 "Identification for Electrical Systems."
 1. Receptacles and Switches: Identify panelboard and circuit number from which served. Use self-adhesive labels with black lettering on white field mounted 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. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
 - B. Tests for Convenience Receptacles:
 1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of six percent (6%) 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 convenience outlets in patient-care areas and 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.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, enclosed controllers and motor-control centers.
- 2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches.
- 3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
- 4. Spare-fuse cabinets.

1.3 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. Fuse sizes for elevator feeders and elevator disconnect switches.

- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

- 1. Ambient temperature adjustment information.
- 2. Current-limitation curves for fuses with current-limiting characteristics.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-12 for plug fuses.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to ten percent (10%) of quantity installed for each size and type, but no fewer than two (2) of each size and type.

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, non-renewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 PLUG FUSES

- A. Characteristics: UL 248-12, non-renewable plug fuses; 125-V ac.

2.4 PLUG-FUSE ADAPTERS

- A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuse holders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

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, fast acting.
 - 2. Motor Branch Circuits: Class RK1, time delay.
 - 3. Other Branch Circuits: Class J, fast acting.
 - 4. Control Circuits: Class CC, fast acting.
- B. Plug Fuses:
 - 1. Motor Branch Circuits: Edison-base type, single-element time delay.
 - 2. Other Branch Circuits: Edison-base type, single-element fast acting.

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 fuse holders and sockets. Ensure that adapters are irremovable once installed.
- C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Molded-case switches.
 - 7. 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 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. Submit on translucent log-log graph paper.

- 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.
- C. Qualification Data: For qualified testing agency.
- D. 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.
- E. 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.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "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. Submit on translucent log-log graph paper.

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. 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.

1.7 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 and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- 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 Architect and Construction Manager no fewer than seven (7) 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 Architect and Construction Manager written permission.
 - 4. Comply with NFPA 70E.

1.8 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.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to ten percent (10%) of quantity installed for each size and type, but no fewer than three (2) of each size and type.
 - 2. Fuse Pullers: Two (2) for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric
- B. Type HD, Heavy Duty, Single Throw, 600-V ac and 240-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 (3) padlocks and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six-Pole, Single Throw, 600-V ac and 240-V ac, 200 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 (3) padlocks and interlocked with cover in closed position.

- D. Type HD, Heavy Duty, Double Throw, 600-V ac and 240-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 (3) padlocks and interlocked with cover in closed position.
- E. 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. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Auxiliary Contact Kit: Two (2) NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 7. Lugs: Mechanical and/or Compression type, suitable for number, size, and conductor material.
 - 8. Service-Rated Switches: Labeled for use as service equipment.

2.2 NON-FUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric
- B. Type HD, Heavy Duty, Single Throw, 600-V ac and 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three (3) padlocks and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac and 240-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three (3) padlocks and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, 600-V ac and 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three (3) padlocks and interlocked with cover in closed position.
- E. 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. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Auxiliary Contact Kit: Two (2) NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical and/or Compression type, suitable for number, size, and conductor material.

2.3 RECEPTACLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric
- B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 600-V ac and 240-V ac, 100 A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate indicated fuses; lockable handle with capability to accept three (3) padlocks; interlocked with cover in closed position.
- C. Type HD, Heavy-Duty, Single-Throw Non-Fusible Switch: 600-V ac and 240-V ac, 100 A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three (3) padlocks; interlocked with cover in closed position.
- D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
- E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

2.4 SHUNT TRIP 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. Cooper Bussmann, Inc.
 2. Ferraz Shawmut, Inc.
 3. Littelfuse, Inc.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three (3) padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:

1. Oil-tight key switch for key-to-test function.
2. Oil-tight green ON pilot light.
3. Isolated neutral lug; two hundred percent (200%) rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac and/or 24-V dc coil voltage.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.5 MOLDED-CASE CIRCUIT BREAKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
 3. Siemens Energy & Automation, Inc.
 4. 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. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- J. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical and/or Compression 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. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at thirty-five to seventy-five percent (35-75%) of rated voltage without intentional time delay.
7. Auxiliary Contacts: Two (2) SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Alarm Switch: One (1) NC contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic and/or ground-fault trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Provide remote control for on, off, and reset operations.

2.6 MOLDED-CASE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 1. Standard frame sizes and number of poles.
 2. Lugs: Mechanical and/or Compression type, suitable for number, size, trip ratings, and conductor material.
 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 5. Undervoltage Trip: Set to operate at thirty-five to seventy-five percent (35-75%) of rated voltage without intentional time delay.
 6. Auxiliary Contacts: Two (2) SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
 7. Alarm Switch: One (1) NC contact that operates only when switch has tripped.
 8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
 9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
 10. Electrical Operator: Provide remote control for on, off, and reset operations.
 11. Accessory Control Power Voltage: Integrally mounted, self-powered; 120-V ac and 24-V dc.

2.7 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. Kitchen and/or Wash-Down Areas: NEMA 250, Type 4X.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 12.
 - 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9.

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 Section 260548 "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. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 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 sixty (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 eleven (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.
- B. Set field-adjustable circuit-breaker trip ranges as specified

END OF SECTION 262816

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Interior solid-state luminaires that use LED technology.
- 2. Lighting fixture supports.

B. Related Requirements:

- 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Arrange in order of luminaire designation.
- 2. Include data on features, accessories, and finishes.
- 3. Include physical description and dimensions of luminaires.
- 4. Include emergency lighting units, including batteries and chargers.
- 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
- 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79 and IES LM-80.

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Shop Drawings: For non-standard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each luminaire housing supply at submittal stage a paint chip of the fixture color as specified on the fixture schedule for approval.
- D. For luminaires and lamps ref to Product Schedule: Shipping carton/box designation to be clearly marked with same designations as indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Lighting luminaires.
 - 2. Suspended ceiling components.
 - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
 - 4. Structural members to which equipment and or luminaires will be attached.
 - 5. Initial access modules for acoustical tile, including size and locations.
 - 6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Ceiling-mounted projectors.
 - 7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

- D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of luminaire.
- F. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and/or manufacturers' model numbers.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps (Arrays) + Driver(s): One (1) spare for every twenty-five (25) of each type and rating installed. Furnish at least one (1) of each type.
 - 2. Diffusers and Lenses: One (1) for every ten (10) of each type and rating installed. Furnish at least one (1) of each type.
 - 3. Globes and Guards: One (1) for every ten (10) of each type and rating installed. Furnish at least one (1) of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. Bulb shape complying with ANSI C79.1.
- F. Lamp base complying with ANSI C81.61 (where applicable).
- G. CRI of minimum 80. CCT of 4000K.
- H. Rated lamp life of 50,000 hours.
- I. Lamps dimmable from one hundred to zero percent (100-0%) of maximum light output.
- J. Internal driver.
- K. Nominal Operating Voltage: 120-277 VAC.
 - 1. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- L. Housings:
 - 1. Extruded-aluminum or aluminum housing and heat sink.

2. Finish approval by Architect and Owner from manufacturer's entire range.

M. Manufacturer – Basis-of-Design: See Fixture Schedule on Drawings.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent (100%) virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum or aluminum housing and heat sink.
2. Powder-coat finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and non-metallic channel and angle supports.
- B. Single-Stem Hangers: ½-inch steel tubing with swivel ball fittings and ceiling canopy. Finish, same as luminaire.
- C. Wires: ASTM A 641, Class 3, soft temper, zinc-coated steel, 12-gage.

- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of one hundred twenty-five percent (125%) of luminaire weight and vertical force of four hundred percent (400%) of luminaire weight.
- E. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four (4) points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls or bracing detail if shown on Drawings.
 - 2. Do not attach luminaires directly to gypsum board.
- G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two (2) 5/32-inch diameter aircraft cable supports adjustable to 120 inches in length.
2. Pendant mount requirements per fixture schedule model number.
3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one (1) point and rod or wire support for suspension for each unit length of luminaire chassis, including one (1) at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four (4) locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two (2) visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.

2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 265219 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - a. Testing Agency Certified Data: For all luminaires, photometric data certified by a qualified independent testing agency.
- B. Shop Drawings: For non-standard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Luminaires.
 2. Suspended ceiling components.
 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
 4. Structural members to which equipment will be attached.
 5. Size and location of initial access modules for acoustical tile.
 6. Items penetrating finished ceiling including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Ceiling-mounted projectors.
 - e. Sprinklers.
 - f. Access panels.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Product Certificates: For each type of luminaire.
- D. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.
- F. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

- B. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- C. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two (2) years from date of Substantial Completion.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Power Unit Batteries: Five (5) years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four (4) years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with UL 1598 for fluorescent luminaires.
- F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.
- G. Bulb Shape: Complying with ANSI C79.1.
- H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
 - 1. Emergency Connection: Operate one (1) lamp continuously at an output of 1100 lumens each upon loss of normal power. Connect un-switched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to eighty percent (80%) of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than ninety-five percent (95%) (condensing).
 - d. Altitude: Exceeding 3300 feet.
 - 4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 5. Battery: Sealed, maintenance-free, nickel-cadmium or lead-acid type as scheduled.
 - 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - 7. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - 8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- I. Refer to Section 260923 "Lighting Control Devices" for requirements for UL924 emergency shunt relays.

2.3 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency Luminaires:
 - 1. Emergency Luminaires: Shall be as indicated on Lighting Fixture Schedule on Drawings and described in Section, with the following additional features:
 - a. Operating at nominal voltage of 12 V dc.
 - b. Internal emergency power unit.
 - c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
 - d. UL 94 5VA flame rating.
- C. Remote Emergency Lighting Units:
 - 1. Emergency Lighting Unit: Shall be as indicated on Lighting Fixture Schedule on Drawings.
 - 2. Operating at nominal voltage of 12 V dc.
 - 3. Wall mount with universal junction box adaptor.
 - 4. UV stable thermoplastic housing, rated for wet locations.
 - 5. Two (2) LED lamp heads.
 - 6. External emergency power unit.

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Operating at nominal voltage of 277 V ac.
 - 2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
 - 3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
 - 4. Master/Remote Sign Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
 - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.
 - 5. Exit Signs wired to emergency lighting power source (AC type): Shall be wired through a UL 924 listed relay providing connection to emergency lighting circuit with an alternate non-emergency circuit (normal lighting) to power the sign on a loss of the emergency circuit.
- C. Photoluminescent Signs:
 - 1. Use strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Include universal bracket for flush-ceiling, wall, or end mounting.

2. Unit shall be UL 924 listed for use above the door and for low-level applications for minimum 90-minute durations.
 3. Furnish with extruded aluminum frame and concealed mounting hardware.
 4. Chevrons shall be self-adhesive type, meeting NFPA requirements.
 5. Unit shall carry 10-year warranty.
- D. Specified Signs for Accessible Exit shall meet power and illumination requirements for exit signs. These shall be furnished with universal symbol of accessibility (wheelchair symbol – dynamic character) having a minimum height of 6 inches and meeting the requirements of IBC 1011.1.2.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Prismatic or Clear, UV-stabilized acrylic.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Acrylic: One hundred percent (100%) virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

D. Housings: Extruded aluminum or polycarbonate housing as scheduled.

E. Conduit: Rigid galvanized steel, minimum 3/4-inch in diameter.

2.6 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and non-metallic channel and angle supports.
- B. Support Wires: ASTM A 641, Class 3, soft temper, zinc-coated steel, 12-gage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of one hundred percent (100%) of luminaire and emergency power unit weight and vertical force of four hundred percent (400%) of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four (4) locations, spaced near corners of emergency power unit.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four (4) locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform Startup Service: Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

- A. Adjustments: Within twelve (12) months of date of Substantial Completion, provide on-site visit to do the following:
 - 1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
 - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265219

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Non-metallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Non-metallic wireways and auxiliary gutters.
6. Surface pathways.
7. Boxes, enclosures, and cabinets.
8. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 1. Structural members in paths of pathway groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.
- D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Alpha Wire Company
 - 4. Anamet Electrical, Inc.
 - 5. Electri-Flex Company
 - 6. O-Z/Gedney; a brand of EGS Electrical Group
 - 7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
 - 8. Republic Conduit
 - 9. Robroy Industries
 - 10. Southwire Company
 - 11. Thomas & Betts Corporation
 - 12. Western Tube and Conduit Corporation
 - 13. Wheatland Tube Company; a division of John Maneely Company
- B. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040-inch, minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.

- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel or die cast.
 - b. Type: Setscrew or compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040-inch, with overlapping sleeves protecting threaded joints.
- I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NON-METALLIC CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.
 - 4. Arnco Corporation
 - 5. CANTEX Inc.
 - 6. CertainTeed Corp.
 - 7. Condux International, Inc.
 - 8. Electri-Flex Company
 - 9. Kraloy
 - 10. Lamson & Sessions; Carlon Electrical Products
 - 11. Niedax-Kleinhuis USA, Inc.
 - 12. RACO; a Hubbell company
 - 13. Thomas & Betts Corporation
- B. General Requirements for Non-metallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Rigid HDPE: Comply with UL 651A.
- E. Continuous HDPE: Comply with UL 651B.
- F. RTRC: Comply with UL 1684A and NEMA TC 14.
- G. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Alpha Wire Company
2. Arnco Corporation
3. Endot Industries Inc.
4. IPEX
5. Lamson & Sessions; Carlon Electrical Products

- B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by 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.
2. Comply with TIA-569-B.

- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

- D. Wireway Covers: Hinged or Screw-cover type unless otherwise indicated.

- E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE PATHWAYS

- A. General Requirements for Surface Pathways:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

- B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Mono-Systems, Inc.
 - b. Niedax-Kleinhuis USA, Inc.
 - c. Panduit Corp.
 - d. Wiremold/Legrand

- C. Surface Non-metallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL-94 V-0 requirements for self-extinguishing characteristics.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems Division
 - b. Lamson & Sessions; Carlon Electrical Products
 - c. Mono-Systems, Inc.
 - d. Panduit Corp.
 - e. Wiremold/Legrand

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Adalet
 - 2. Cooper Technologies Company; Cooper Crouse-Hinds
 - 3. EGS/Appleton Electric
 - 4. Erickson Electrical Equipment Company
 - 5. Hoffman; a Pentair company
 - 6. Hubbell Incorporated; Killark Division
 - 7. Lamson & Sessions; Carlon Electrical Products
 - 8. Milbank Manufacturing Co.
 - 9. Molex; Woodhead Brand
 - 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:
 - 1. Comply with TIA-569-B.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

- H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- I. Gangable boxes are prohibited.
- J. Non-metallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- K. 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. Non-metallic Enclosures:
 - a. Material: Plastic.
 - b. Finished inside with radio-frequency-resistant paint.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. 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. Non-metallic 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 PATHWAY APPLICATION

- A. Refer to Section 260533 "Raceway and Boxes for Electrical Systems".
- B. Minimum Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1-inch.
- C. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Install surface pathways only where indicated on Drawings.
- F. Do not install non-metallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two (2) 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus $\frac{1}{4}$ turn more.
- N. Do not rely on locknuts to penetrate non-conductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- O. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- Q. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two (2) supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- R. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and non-metallic, rigid and flexible, as follows:
1. $\frac{3}{4}$ -Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 3. Install with a maximum of two (2) 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- S. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- T. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- V. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041-inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.00078-inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

- 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
 - W. 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 top of box unless otherwise indicated.
 - X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
 - Y. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
 - Z. Support boxes of three (3) gangs or more from more than one (1) side by spanning two (2) 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.
- 3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS
- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."
- 3.4 FIRESTOPPING
- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.
- 3.5 PROTECTION
- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized-steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052-inch.

- b. For sleeve cross-section rectangle perimeter 50 inches or more and one (1) or more sides larger than 16 inches, thickness shall be 0.138-inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The)
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel.
 - 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, water-stop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber water-stop collar with center opening to match piping OD.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - a. Presealed Systems

2.4 GROUT

- A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, twenty-eight (28) day compressive strength.
- D. Packaging: Pre-mixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

- B. Silicone Foams: Multi-component, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall, so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide ¼-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical

sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water-stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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. The scope of work required as part of this project shall include (1) new Telecommunication Room. This area shall include floor mounted 2-post and/or 4-post racks, server cabinets, ladder racking, and wall mounted devices as indicated within the drawing details.
- B. Section Includes:
 - 1. Telecommunications mounting devices.
 - 2. Backboards.
 - 3. Telecommunications equipment racks and cabinets.
 - 4. Telecommunications service entrance pathways.
 - 5. Grounding and bonding.
- C. Related Requirements:
 - 1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
 - 2. Section 271500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. BICSI: Building Industry Consulting Service International.
- C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches in width.
- D. Ladder Cable Tray: A fabricated structure consisting of two (2) longitudinal side rails connected by individual transverse members (rungs).
- E. LAN: Local Area Network.
- F. RCDD: Registered communications distribution designer.
- G. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.
- H. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using seventy-five percent (75%) or less of the plan area of the surface to support cables.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Seismic Qualification Data: Certificates, 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. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

- A. Installation of products shall be performed in accordance with the Manufacturer's recommended procedures.
- B. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD/NTS and/or Commercial Installer, Level 2.
 - 2. Installation Supervision: Installation shall be under direct supervision of Registered Technician and/or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD and/or Commercial Installer, Level 2 to perform the on-site inspection.
- C. Telecommunications Pathways and Spaces shall comply with TIA-569-C.
- D. Grounding shall comply with ANSI-J-STD-607-A.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install equipment racks, cabinets, frames, or cable trays until spaces are enclosed, built-out and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.8 COORDINATION

- A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier/Service Providers.
- B. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
- C. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of the Voice equipment, LAN equipment, Security Equipment, and all other systems that share space within the Telecommunication Equipment rooms.
- D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Equipment 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 when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 PATHWAYS

- A. General Requirements: Comply with TIA-569-C.
- B. Riser and distribution cables leaving the room to building TRs should be via cable tray, 4-inch conduits or sleeved cores.
- C. The exact number of conduits required or size of the cable wireway should be determined based upon the amount of fiber and copper cable that must be supported in each closet and each computer or communications room.
- D. Additional conduits or sleeved cores must be included in the design to provide for future growth.
- E. All conduits/coring should be kept 6 inches or less from walls whenever construction permits.
- F. Cable Support: Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening cable ties to brackets.
3. Lacing bars, spools, J-hooks, and D-rings.
4. Straps and other devices.

G. Conduit and Boxes: Refer to Section 260533 "Raceways and Boxes for Electrical Systems".

2.3 UPS'

- A. The selected manufacturer shall be American Power Conversion Corp., USA in West Kingston, RI. Other manufacturers will be considered, providing equipment meets or exceeds the quality specified and they can provide equipment of the type, size and function required.
- B. Each rack shall be provided with one (1) **APC SMT3000RMXLT**, 208-volt Smart-UPS. One (1) UPS per closet shall be provided with **AP9631** network management card with environmental monitoring. All other UPS units in the same closet shall be provided with **AP9630** standard network management card.

2.4 EQUIPMENT FRAMES

- A. Manufacturers: Subject to compliance with requirements, provide products as indicated on Drawings or comparable ones by one (1) of the following:
 1. Chatsworth Products, Inc.
 2. Great Lakes
 3. Hubbell
 4. Middle Atlantic
- B. General Frame Requirements:
 1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 2. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
 3. Finish: Manufacturer's standard, baked-polyester powder coat.
- C. Floor-Mounted Racks: Modular-type, steel construction.
 1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
 2. Baked-polyester powder coat finish.
- D. Cable Management for Equipment Frames:
 1. Metal, with integral wire retaining fingers.
 2. Baked-polyester powder coat finish.
 3. Vertical cable management panels shall have front and rear channels, with covers.
 4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Install underground pathways complying with recommendations in TIA-569-C.
- C. Install underground entrance pathway complying with Section 260533 "Raceway and Boxes for Electrical Systems".

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
- C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. All conduits etc., passing through fire rated floors, walls, and partitions, shall have the space between the raceways, sleeves, and all penetrations filled with a reusable firestopping material.

3.4 GROUNDING

- A. Comply with ANSI-J-STD-607-A.
- B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. The grounding system must be intentional, visually verifiable, and adequately sized to handle expected currents safely. The grounding system shall be designed and installed in accordance with the NECA/BICSI 607-2011 Standard for Bonding and Grounding Planning for commercial buildings.
- E. Telecommunications Grounding Busbar:
 - 1. Telecommunications Grounding Busbars or TGBs are located in Telecommunications Rooms (TR) to provide grounding for racks, enclosures, and equipment in these spaces.
 - 2. The length of this bar is determined by the amount of connections that will be made to it, but the minimum thickness is ¼-inch and the minimum width is 2 inches.
 - 3. TGBs shall be electroplated for reduced contact resistance.
 - 4. The TGB shall be mounted using minimum 2-inch insulated standoffs.

5. All metal racks, enclosures, equipment, and cable pathways entering these spaces shall be bonded to the TGB using minimum #6 AWG wire and crimp or weld-on lugs.
6. All exposed/accessible building steel within these spaces shall be bonded to the TGB using minimum #6 AWG wire and crimp or weld-on lugs.
7. TGBs shall be assigned a unique identification and permanently labeled.

F. Rack Grounding:

1. Electrical continuity throughout each rack or cabinet is required to minimize safety risks. The racks shall be assembled using paint-piercing grounding washers (Panduit Part no. **RGW**, or approved substitute) and antioxidant (per the recommendations of the manufacturer). An electrostatic discharge port kit (Panduit **RGESD**, or approved substitute) shall be placed on the rack (on the right side when facing the rack) at 40 inches above the floor. All bonding connections to the rack shall be made with thread-forming screws (Panduit Part no. **RGTS**, or approved substitute), or the threads must be cleaned of all paint or residue (per the NEC).
2. In locations with multiple racks, the rack shall be connected to the common bonding network with a #6 AWG conductor and a copper compression HTAP. In locations with single racks, a #6 AWG conductor to the busbar is sufficient. The common bonding network is a 2 AWG continuous conductor placed below or above the racks. Refer to NECA/BICSI 607-2011 for design recommendations.

G. Rack Compression Fitting:

1. Lugs and HTAPs must be manufactured of tin-plated copper and fastened via irreversible compression (crimped). Lugs shall have spacing to fit Panduit **GB** series pre-drilled busbars and a window to allow for inspection of the crimp. HTAPs shall be contained in clear covers that allow inspection of the die marks to ensure that the proper die was used.
2. Approved Lugs:
 - a. Burndy; **YAZ series**
 - b. CPI
 - c. Electric Motion Company; **CCL Series**
 - d. Panduit; **LCC or LCCX series**
3. Approved HTAPS:
 - a. Burndy; **YH series** (when used with clear covers)
 - b. Panduit; **HTWC series**

H. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 260553 "Identification for Electrical Systems." Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- B. Backboard and Equipment Racks:

1. Backboards and equipment racks shall be labeled by the Contractor identifying the Telecommunication Room. Additionally, equipment racks shall have an alpha character after the room number unique to that particular communications closet. For example, TR1-A would be the first rack in TR1.
 2. Character height shall be 1-inch (minimum).
- C. See Section 271500 "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2, Class 3, or Class 4 level of administration including optional identification requirements of this standard.
- D. Labels shall be pre-printed or computer-printed type.

END OF SECTION 271100

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pathways.
 - 2. UTP cable.
 - 3. Multi-mode: OM3, 50/125 micrometer, 24-strand, armored optical fiber cabling.
 - 4. Single mode optical fiber cabling, 24-strand, armored optical fiber cabling.
 - 5. Coaxial cable.
 - 6. Cable connecting hardware, patch panels, and cross-connects.
 - 7. Cabling identification products.
 - 8. Testing procedures.
- B. Related Sections:
 - 1. Division 271100 Section "Communications Equipment Room Fittings".

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. EMI: Electromagnetic interference.
- D. IDC: Insulation displacement connector.
- E. LAN: Local area network.
- F. RCDD: Registered Communications Distribution Designer.
- G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

- A. Backbone cabling system shall provide interconnections between telecommunications equipment rooms and the rest of the facility for the voice/data cabling systems.
- B. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patching or jumpers used for backbone-to-backbone cross-connection to service provider equipment.

- C. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For coaxial cable, include the following installation data for each type used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.
- B. Shop Drawings:
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. Cabling administration drawings and printouts.
 - 3. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
 - 4. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to side of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and field-testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications:

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.2 and TIA-568-C.3, when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-C.
- D. Grounding: Comply with ANSI-J-STD-607-A.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PATHWAYS

- A. General Requirements: Comply with TIA-569-C.
- B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
 - 2. Lacing bars, spools, J-hooks, and D-rings.
 - 3. Straps and other devices.
- C. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
 - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2½ inches deep.

2.3 UTP CABLE

- A. Description: Voice Backbone Cabling.
- B. Cable shall be 100-ohm, 100 -pair UTP, formed into 25-pair binder groups, plenum rated cable.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA-568-C.2 for performance specifications.
 - 3. Comply with TIA-568-C.2, Category 5E.
- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include and are limited to the following:
 - 1. Belden
 - 2. Berk-Tek
 - 3. Superior Essex

2.4 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include and are limited to the following:
 - 1. Belden
 - 2. Hubbell Premise Wiring
 - 3. Leviton
- B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 5E. Provide blocks for the number of cables terminated on the block, plus twenty-five percent (25%) spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. 100-pair, 110-style CAT 5E 19-inch rack mounted patch panels to allow for cross-connection from voice origination (PBX) to workstations via CAT 5E patch cords.
- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One (1) for each conductor in assigned cables.
- F. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
1. Number of Jacks per Field: One (1) for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
- G. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- 2.5 OPTICAL FIBER CABLE
- A. Description: Data Backbone Cabling.
- B. 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. Belden
 2. Berk-Tek
 3. Superior Essex
- C. Description: Multi-mode, OM3, 50/125, 24-fiber, non-conductive, tight buffer, armored optical, plenum rated, fiber cable.
1. Comply with ICEA S-83-596 for mechanical properties.
 2. Comply with TIA-568-C.3 for performance specifications.
 3. Comply with TIA-492AAAC-A-2003, Detail Specification for 850-nm Laser-Optimized, 50- μ m Core Diameter/125- μ m Cladding Diameter Class 1a Graded-Index Multi-mode Optical Fibers for detailed specifications.
 4. Maximum Attenuation: Conform to ANSI/TIA-455-78-B-2002, Optical Fibers Part 1-40: Measurement Methods and Test Procedures – Attenuation: 2.50 dB/km at 850 nm; 1.0 dB/km at 1300 nm.
 5. Minimum Modal Bandwidth, Conform to TIA-492-AAAC: 1500 MHz-km at 850 nm; 500 MHz-km at 1300
- D. Description: Single mode, 24-fiber, non-conductive, tight buffer, armored optical, plenum rated, fiber cable.
1. Comply with ICEA S-83-596 for mechanical properties.
 2. Comply with TIA-568-C.3 for performance specifications.
 3. Comply with TIA-492-CAABxx for detailed specifications.
 4. Maximum Attenuation: 1.0 dB/km at 1340 nm; 1.0 dB/km at 1550 nm.
- E. Jacket:
1. Jacket Color: Single mode, aqua; multi-mode, orange.
 2. Armored fiber jacket required. Inter-locking armor shall be made of aluminum.
 3. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
 4. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

- 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. Belden
 - 2. Hubbell Premise Wiring
 - 3. Legrand- Ortronics
 - 4. Leviton
- B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - 1. Number of Connectors per Field: One (1) for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- C. Cable Connecting Hardware:
 - 1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2, TIA-604-3-A, and TIA-604-12. Comply with TIA-568-C.3.
 - 2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
 - 3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 COAXIAL CABLE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - 1. Alpha Wire Company
 - 2. Belden Inc.
 - 3. Coleman Cable, Inc.
 - 4. CommScope, Inc.
 - 5. Draka Cableteq USA
- B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
- C. RG-6/U: NFPA 70, Type CATV or CM.
 - 1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 - 2. Double shielded with 100 percent aluminum-foil shield and sixty percent (60%) aluminum braid.
 - 3. Jacketed with black PVC or PE.
 - 4. Suitable for indoor installations.
- D. NFPA and UL compliance listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
 - 1. CATV Cable: Type CATV.
 - 2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
 - 3. CATV Riser Rated: Type CATVR, complying with UL 1666.
 - 4. CATV Limited Rating: Type CATVX.

2.8 COAXIAL CABLE HARDWARE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
 - 1. Emerson Network Power Connectivity Solutions
 - 2. Leviton Commercial Networks Division
 - 3. Siemon Co. (The)
- B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.9 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including etching, label stocks, laminating adhesives, and inks used by label printers.
- B. Labeling of all cable is described within the drawing documents.

2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.2.
- C. Factory test UTP cables according to TIA-568-C.2.
- D. Factory test multi-mode optical fiber cables according to TIA-526-14-A and TIA-568-C.3.
- E. Cable will be considered defective if it does not pass tests and inspections.
- F. Each Fiber Optic Termination Panel shall be clearly labeled indicating (1) the destination(s) of the cable(s) and (2) fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.
- G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and J-hooks except where cable trays are required in Drawings. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

- B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- C. Pre-terminated fiber optic cabling will be accepted. Manufacturer shall be approved upon product submission.

3.3 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and TIA-569-C.
- B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.
- C. Comply with TIA-569-C for pull-box sizing and length of conduit and number of bends between pull points.
- D. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- E. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- F. Pathway Installation in Communications Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard when entering room from overhead.
 - 4. Extend conduits 3 inches above finished floor.
 - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.4 INSTALLATION OF CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.2.
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist UTP cables more than ½-inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA-568-C.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-C recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in non-metallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2½ inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

- a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-C.
- C. Comply with BICSI ITSIMM, "Firestopping Systems" Article.

3.6 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Administration Class: Class 2.
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Clearly label all Data Patch Panels via etching, as indicating the Telecommunication Room Number, The Data Patch Panel letter designation and the Data Port Number on the Data Patch Panel Ports 1 through 48. Each Telecommunication Room shall start with Data Patch Panel 'A' and continue through the Alphabet.
- D. See Section 271500 "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration including optional identification requirements of this standard.

- E. Comply with requirements in Section 271500 "Communications Horizontal Cabling" for cable and asset management software.
- F. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- G. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- H. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 - 6. All fiber optic backbone and copper (inter-building, riser and tie) cables shall be identified AT BOTH ENDS with a designation that identifies where the opposite end of the same cable terminates (e.g. Equipment Room or Telecommunications Room I.D.). In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.
 - 7. Each fiber optic termination panel shall be clearly labeled indicating the destination of the cable(s) and the fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.
- I. Labels shall be pre-printed or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:
 - 1. Flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
4. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Multi-mode backbone link measurements: Test at 850 and 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
 - 2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.3.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. UTP cabling.
 - 2. Pathways.
 - 3. Multi-user telecommunications outlet assemblies.
 - 4. Cable connecting hardware, patch panels, and cross-connects.
 - 5. Telecommunications outlet/connectors.
 - 6. Cabling system identification products.
 - 7. Cable management system.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- D. EMI: Electromagnetic interference.
- E. IDC: Insulation displacement connector.
- F. LAN: Local area network.
- G. MUTOA: Multi-user telecommunications outlet assembly, a grouping in one (1) location of several telecommunications' outlet/connectors.
- H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- I. RCDD: Registered Communications Distribution Designer.
- J. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For coaxial cable, include the following installation data for each type used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.
- B. Shop Drawings:
 - 1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 2. Cabling administration drawings and printouts.
 - 3. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Cross-connects.
 - b. Patch panels.
 - c. Patch cords.
 - 4. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
 - B. Testing Agency Qualifications: An NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Test cables upon receipt at Project site.
 1. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 1. TIA/EIA-568-B.1 requires that a minimum of two (2) telecommunications outlet/connectors be installed for each work area.
 2. Horizontal cabling shall contain no more than one (1) transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 4. Splitters shall not be installed as part of the optical fiber cabling.
- B. A work area is approximately 100 sq. ft. and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

2.3 UTP CABLE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
1. ADC
 2. Belden Inc.
 3. Berk-Tek; a Nexans company
 4. CommScope, Inc.
 5. Draka Cableteq USA.
 6. Genesis Cable Products; Honeywell International, Inc.
 7. Mohawk; a division of Belden Networking, Inc.
 8. Superior Essex Inc.
 9. SYSTIMAX Solutions; a CommScope, Inc. brand
 10. 3M Communication Markets Division
 11. Tyco Electronics Corporation; AMP Products
- B. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 3. Comply with TIA/EIA-568-B.2, Category 6.
 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, General Purpose: Type CM or CMG.
 - b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
 - c. Communications, Riser Rated: Type CMR, complying with UL 1666.
 - d. Communications, Limited Purpose: Type CMX.

2.4 UTP CABLE HARDWARE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:
1. ADC
 2. American Technology Systems Industries, Inc.
 3. Belden Inc.
 4. Dynacom Inc.
 5. Hubbell Premise Wiring
 6. Leviton Commercial Networks Division
 7. Molex Premise Networks; a division of Molex, Inc.
 8. Panduit Corp.
 9. Siemon Co. (The)
 10. Tyco Electronics Corporation; AMP Products
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus twenty-five percent (25%) spare. Integral with connector bodies, including plugs and jacks where indicated.

- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: One (1) for each conductor in assigned cables.
- E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - 1. Number of Jacks per Field: One (1) for each four-pair UTP cable indicated.
- F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- G. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.

2.5 PATHWAYS

- A. General Requirements: Comply with TIA/EIA-569-A.
- B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
 - 2. Lacing bars, spools, J-hooks, and D-rings.
 - 3. Straps and other devices.
- C. Cable Trays:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Cable Management Solutions, Inc.
 - b. Cablofil Inc.
 - c. Cooper B-Line, Inc.
 - d. Cope - Tyco/Allied Tube & Conduit
 - e. GS Metals Corp.
 - 2. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inches thick.
 - a. Trough Cable Trays: Nominally 6 inches wide.
 - b. Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches.
- D. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems."
 - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2½ inches deep.

2.6 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: Multi-port-connector assemblies mounted in single faceplate.
 - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
 - 3. Legend: Machine printed, in the field, using adhesive-tape label or Snap-in, clear-label covers and machine-printed paper inserts.

2.7 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with J-STD-607-A.

2.8 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.9 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- E. Cable will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 2. Install lacing bars and distribution spools.
 3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 1. Comply with TIA/EIA-568-B.1.
 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 3. Install 110-style IDC termination hardware unless otherwise indicated.
 4. MUTOA shall not be used as a cross-connect point.
 5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for UTP at least 49 feet from communications equipment room.
 6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 12. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
 13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation:
 1. Comply with TIA/EIA-568-B.2.
 2. Do not untwist UTP cables more than ½ inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in non-metallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2½ inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 FIRESTOPPING

- A. Comply with TIA-569-B, Annex A, "Firestopping."
- B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.

- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
- B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
- C. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.
- E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- F. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 - 6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

- G. Labels shall be pre-printed or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

- 1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

- 1. Visually inspect UTP cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color coding for pin assignments and inspect cabling connections for compliance with TIA/EIA-568-B.1.
- 2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels
- 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and patch cords, and labeling of all components.
- 4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568- B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- 5. UTP Performance Tests: Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
 - a. Wire map.
 - b. Length (physical vs. electrical, and length requirements).
 - c. Insertion loss.
 - d. Near-end crosstalk (NEXT) loss.
 - e. Power sum near-end crosstalk (PSNEXT) loss.
 - f. Equal-level far-end crosstalk (ELFEXT).
 - g. Power sum equal-level far-end crosstalk (PSELFEXT).
 - h. Return loss.
 - i. Propagation delay.
 - j. Delay skew.
- 6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

- B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 271500

SECTION 274120 - AUDIO-VISUAL 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. Interactive Display, Mount, & Backbox.
 - 2. Classroom Speaker System.
 - 3. Classroom AV Cabling & Faceplates.
 - 4. Cabling.

1.3 EXAMINATION OF SITE AND DOCUMENTS

- A. The Trade Contractor for this Section shall examine all Drawings and all Sections of the Specification for requirements therein that may affect the Work of this Section, not just those Drawings and Specifications particular to the Work of this Section. The Work of this Section is shown primarily on the following listed Drawings:
 - 1. Architectural
 - 2. Electrical
- B. Bidders are expected to examine and be thoroughly familiar with all contract documents and with the conditions under which work will be carried out. The Owner will not be responsible for errors, omissions, and/or charges for extra work arising from Contractor's failure to familiarize themselves with the Contract Documents or existing conditions. By submitting a bid, the Bidder agrees and warrants that he has had the opportunity to examine the site and the Contract Documents, that he is familiar with the conditions and requirements of both and where they require, in any part of the work a given result to be produced, that the Contract Documents are adequate and that he will produce the required results.

1.4 SCOPE OF WORK

- A. Furnish and install sound and communication systems as shown on Drawings and as specified herein, complete with all apparatus, equipment, power supplies, wiring, labor, and services necessary to ensure a complete working system. Verify completeness of equipment listed and correctness of type numbers. Furnish and install supplementary equipment needed to meet system requirements, without claim for added payment. Labor furnished shall be specialized and experienced in Systems installation.
- B. This work includes, but is not limited to the following:
 - 1. Furnish all back boxes and enclosures.
 - 2. Furnish and install all wire and cable.
 - 3. Furnish any additional items, not specifically mentioned herein, to meet system requirements as specified, without claim for additional payment. Such items may

- include hardware, transformers, line/distribution amplifiers, and other devices for proper installation, interface, isolation or gain structure.
4. Submission of shop drawings prior to fabrication.
 5. Verification of dimensions and conditions at the job site.
 6. Installation in accordance with these specifications, manufacturer's recommendations, and all applicable code requirements.
 7. Setup and adjustment of signal processing, system tests and adjustments, written report, demonstration for approval, participation in acceptance tests, and final adjustments as required.
 8. Programming and documenting of all software-controlled devices including initial setup of presets in all devices.
 9. Coordination with the Electrical Contractor is required to ensure correct systems conduit routing, systems backbox locations, and clean power circuit locations as specified in Division 26 Electrical.
 10. Coordination with the Lighting Contractor.
 11. Coordination with the Fire Alarm Systems Contractor.
 12. Coordination with the Tel/Data Contractor and other Low Voltage Contractors.
 13. Coordination with the Owner's IT department and installers.
 14. Performance standards, without claim for additional payment.
 15. System documentation.
 16. Instruction of Owner's operating personnel.
 17. Maintenance and services for one (1) year.
 18. Guarantee all equipment and components for the specified period from the date of acceptance.

- C. All work described within this section must be coordinated with other trades to ensure a successful installation.

1.5 CONTRACTOR RESPONSIBILITY

- A. Drawings are detailed only to the extent necessary to show design intent and signal flow. It is understood and agreed by the Contractor that the work herein described shall be complete in every detail to supply a complete working system.
- B. Equipment not mentioned herein nor shown on Drawings but necessary to meet this requirement shall be provided without claim for additional payment.

1.6 SUBMITTALS

- A. Shop Drawing Submittals:

1. Within sixty (60) days after contract award, submit two (2) copies of detailed shop drawings to the Architect for approval. All shop drawings shall be marked with the related drawing number when submitted. Do not begin installation or fabrication without the approval of the Architect and Systems Designer.
2. Review of shop drawings shall not constitute final approval of system function. Said review does not in any way relieve the Contractor from the responsibility of furnishing material or performing work as required by the Contract documents.
3. Failure of the Contractor to submit shop drawings in ample time for evaluation shall not entitle the Contractor to an extension of contract time, and no claim for extension by reason of such default will be allowed.
4. At a minimum, the Shop Drawings shall include neatly bound copies of the following:
 - a. A block diagram indicating proposed interconnections of all equipment and indicating equipment types and model numbers.

- b. Drawings of loudspeaker mounting arrangements, equipment rack layouts, and receptacle and control plates and boxes.
 - c. Plate and panel Schedule listing all plates and individually with size, mounting condition, back box size and finish color.
 - d. Drawings showing cable pull assemblies and schedule complete with all wiring requirements for the project.
 - e. Drawings of all final assemblies of loudspeaker suspension equipment.
 - f. Coordinate frequency usage with Owner's designated representative prior to submitted show drawings.
- 1) Submit list of frequencies used in system together with known existing frequency usage in area, including all local television stations.
- 5. The use of electronic files from other sources (e.g., architectural backgrounds, Systems Designer's drawings, vendor-supplied panel drawings) will not absolve the Contractor of responsibility for ensuring that the Shop Drawings represent a completely engineered, coordinated solution. The Contractor has final responsibility for providing systems which conform to all requirements of this specification.
- B. Finishes: Obtain Consultant and Architect approval of all panel and furniture finishes prior to fabrication. The Architect will specify exact finishes.
- C. Field Supervisor: Before beginning installation, submit the name of the employee who will be the on-site field supervisor through the completion of this project.
- D. Qualifications:
 - 1. Bidder shall be a system contractor, normally engaged in the full-time business of audio-visual and sound reinforcement system installation. Provide evidence that the bidder has been in business for at least five (5) years prior to bid date and has completed projects of similar size and scope.
 - 2. References, including names and telephone numbers of individuals who may be contacted, showing satisfactory completion of three or more projects similar in scope and type to that specified herein.
 - 3. Provide additional evidence of satisfactory completion of audio-visual system installations involving suspended loudspeakers, screens, and complex control system integration.
 - 4. Evidence of ability and affirmation of intent to meet the guarantee and service requirements stated herein.
 - 5. Qualifications of certified control system programmer who will be working on this project.

1.7 MATERIALS AND EQUIPMENT

- A. All systems proposed herein shall meet the best commercial practices of the applicable industries, except where alternatives are noted. Publications of issues of the following standards form a part of this specification:
 - 1. American Institute of Architects (AIA)
 - 2. Americans with Disabilities Act (ADA)
 - 3. American National Standards Institute (ANSI)
 - 4. Audio Engineering Society (AES)
 - 5. Computer Security Institute (CSI)
 - 6. Federal Communications Commission (FCC)
 - 7. Institute of Cable Engineers (ICEA)

8. Institute of Electrical and Electronic Engineers (IEEE)
9. International Standards Organization (ISO)
10. International Telecommunications Union (ITU)
11. National Association of Broadcasters (NAB)
12. National Electric Code (NEC)
13. National Electronic Manufacturers Association (NEMA)
14. National Fire Protection Association (NFPA)
15. National Institute for Certification in Engineering Technology (NICET)
16. Occupational Safety and Health Administration (OSHA)
17. Society of Motion Picture and Television Engineers (SMPTE)
18. Telecommunications Industry Association (TIA)
19. Underwriters Laboratories (UL)
20. Nationally recognized standards of the various construction trades, as may be applicable.

B. Substitutions:

1. Subsequent to Contract award, substitutions may be permitted, but only with the express written permission of the Systems Designer. The proposed substitutes must be equivalent to the specified products in quality, performance, construction, function, and conformance to system objectives.
2. It is the responsibility of the Contractor to prove, to the satisfaction of the Systems Designer, that the proposed substitution is equal to the specified product, as demonstrated by submission of the following:
 - a. List of advantages to the Owner.
 - b. Cost savings.
 - c. Printed specifications or laboratory test data.
 - d. Previous field experience.
3. The Contractor shall list the unit price of each item proposed for substitution and indicate which specified items are to be deleted.
4. If the Systems Designer determines that the proposed product is not equal to the specified project, the Contractor shall supply the product specified in the Contract documents.
5. Where substitute materials or methods are approved, the Contractor shall make all adjustments to contingent work necessary to accommodate the substituted equipment, without claim for additional payment.
6. In the event that one (1) or more of the products specified herein is unavailable, the Contractor shall make recommendations to the Systems Designer as to what substitutions are available to meet the intent of the specification.
7. The Systems Designer reserves the right to substitute new products which become available subsequent to the issuance of the Contract Documents, provided:
 - a. The Contractor has not yet purchased the originally specified equipment.
 - b. The substitute equipment shall not materially increase the Contractor's costs.

C. Written Guarantee as described in this section.

D. Verification Test Report as described in this section.

E. System Documentation and Operation Manuals as described in this section.

1.8 JOB CONDITIONS

- A. Keep the job adequately staffed at all times. Unless illness, loss of personnel, or other circumstances beyond the control of the Contractor intervene, keep the same individual in charge throughout.
- B. Cooperate with all appropriate parties in order to achieve well-coordinated progress with the overall construction completion schedule and satisfactory final results.
- C. Watch for conflicts with work of other contractors on the job and execute, without claim for extra payment, moderate moves or changes as are necessary to accommodate other equipment or to preserve acoustic performance, symmetry, and pleasing appearance.
- D. Immediately report to the Architect and Systems Designer, any design or installation irregularities, particularly architectural elements that interfere with the intended coverage angles of loudspeakers, so that appropriate action may be taken.
- E. Do all cutting, patching, and painting for proper and finished installation of the system and repair any damage done as a result of such installation. Clean up and dispose of trash from all Systems work areas.

1.9 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain all materials from one (1) source from a single approved manufacturer for each different product required.
- B. Integrator and installation contractor MUST be a certified installation contractor for all manufacturers used in this installation.
- C. Parts listed shall be complete, type numbers accurate, and equipment furnished shall conform to manufacturer's specifications.
- D. All materials shall be new and shall conform to applicable provisions of Underwriters Laboratories and the American Standards Association.
- E. Procure and pay for all permits, licenses and inspections and observe any requirements stipulated therein. Conform in all trades with all local regulations and codes.
- F. Comply with federal, state, and local labor regulations and applicable union regulations.
- G. Installation shall conform to latest federal, state, and local electrical and safety codes or those of other authorities having jurisdiction. Where conflicts exist, most stringent code or regulation shall apply.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Take care in handling products in accordance with manufacturer's instructions.
- B. Store indoors in original undamaged packaging, in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity. Store products upright in secure, protected area. Do not stack! Verify with manufacturer that site conditions are acceptable before receiving material.
- C. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment: System components installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and twenty to ninety percent (20-90%) relative humidity.

1.11 FUNCTIONAL REQUIREMENTS

- A. The system shall provide the following functions:

1. Classroom Sound Amplification System:

- a. Reinforcement of speech from wireless microphone system to listener in the room through speakers located in the ceiling.
- b. Operator controlled mixing of microphone signals.
- c. Muting of all audio signals in response to fire alarm control signal from fire alarm signal.

1.12 DIAGRAMS, INSTRUCTION MANUALS

- A. Provide draft copies of all required diagrams and instruction manuals on-site for inspection during the demonstration and acceptance testing of the system; submit final copies thereafter.
- B. Simplified Line Diagram: Show the essential parts of the completed installation and their functional relations including all jacks, numbered according to their position on the system patch panels (A, B, etc. for horizontal rows, 1-26 for vertical columns). Mount one (1) copy of the diagram behind clear plastic on the wall near the equipment rack, or as directed. Bind one (1) copy of the diagram into each instruction manual. Reduce the mounted copy to 11 x 17 inches maximum; ensure that it is legible at that size.
- C. Operating Manual: Create system specific user manual for the complete system including user instructions for accessing all the system functionality specified in Function Requirements. Manual should describe how to use individual components in their context as part of a larger system. A compilation of manufacturer's manuals for components does NOT meet this requirement.
- D. Complete Instruction Manuals:
 1. Provide complete instruction manuals which include the following:
 - a. Table of contents.
 - b. List of loose items furnished.
 - c. List of functional requirements.
 - d. Operating manual (see above).
 - e. List of settings and adjustments for semi-fixed controls.
 - f. Manufacturers sheets of specifications, operating instructions, and service information arranged alphabetically by manufacturer and then by model number, for each item of equipment specified herein.
 - g. Detailed system wiring diagrams, including cable schedules, DSP functional diagram printouts and copies of all drawings specified above. Also include all submitted shop drawings to indicate as built conditions.
 - h. Provide to Owner and retain a copy of all operating software, if any, and manuals, including custom software.
 - i. Provide source code for all custom programming created for this project on USB memory stick.

j. Provide print-out of all touch panel pages.

E. Record Drawings:

1. Provide record drawings of as-built conditions in ACAD and PDF file format based on contractor's updated base drawings. Drawings shall include at a minimum:
 - a. Device location plan.
 - b. Functional diagram with wire numbering.
 - c. Wiring details.
 - d. Loudspeaker suspension details.
2. Provide CD with ACAD files and one (1) black line print of drawings.

1.13 INSTRUCTION

- A. Provide instruction of Owner's designated operating personnel. Include a minimum of one (1) 4-hour session of instruction in the operation, care, and maintenance of the installation.
- B. Schedule instruction at the mutual convenience of the Owner and Contractor, after demonstration and acceptance testing. Provide a MP3 recording or otherwise coordinate with the Owner the recording of all instruction sessions and provide a copy of each major session to the Owner.

1.14 GUARANTEE AND SERVICE

- A. All systems and components shall be guaranteed free of defects in materials and workmanship for a period of one (1) year from the date of acceptance and shall be repaired or replaced within 48 hours following report of such defects by the Owner.
- B. The Contractor shall be available on call and on 8-hour notice during the first month following acceptance of the system, to assist the Owner's representatives in any problems that may arise during the initial period of operation.
- C. If, during the Guarantee period, any component is out of service for more than seven (7) consecutive days due to unavailability of parts or service, Contractor shall supply and install an identical new component. If an identical component is not available, Contractor will substitute equivalent equipment, with the approval of the Owner.
- D. During the course of the Guarantee period, the Contractor shall provide a minimum of three (3) service visits to the site for inspection and adjustment of equipment. Contractor shall submit proposed schedule for these visits and shall notify Owner and Systems Designer in writing at least one (1) month in advance of each visit.

1.15 INSURANCE

- A. All equipment and materials shall be fully insured against loss or damage up until acceptance of this system by the Owner or until the Owner relieves the Contractor in writing of this responsibility, whichever is earlier.

PART 2 - PRODUCTS

2.1 DISPLAYS & MOUNTS:

- A. 65" Display shall be Samsung QM65 or equivalent.
 - 1. Approved alternate manufacturers:
 - a. LG
 - b. Philips
- B. The 65" Display mount shall be Chief #LTM1U or equivalent.
- C. The 55" Displays for the video wall in the Media Atrium shall be Samsung #VM55B or equivalent.
 - 1. Approved alternate manufacturers:
 - a. LG
- D. The 55" Display Wall Mount shall be Chief #LVS1UP or equivalent.
 - 1. The video wall mount shall be a rail mount system with proper adjustment for a video wall setting.

2.2 WIRING AND CONNECTIONS

- A. Audio Input Lines: Use cable with a foil shielded pair of stranded #22 AWG conductors, with a stranded shield drawn wire. For single pair, use a miniature cable nominal outside diameter 0.135-inch. Use of a multi-pair cable is optional. Provide plenum rated equivalent as required.
 - 1. Belden **8451**
 - 2. Mohawk **1671**
 - 3. West Penn **452**
- B. Loudspeaker Wiring:
 - 1. Provide unshielded loudspeaker wiring for connection to loudspeakers and loudspeaker receptacles. For lines in rigid conduit or electrical tubing, use stranded or solid conductors. For lines in flexible conduit or electrical tubing and for all wiring to equipment within equipment racks, use only stranded conductors.
 - 2. Use color-coded #12 AWG conductors for all loudspeakers and electronically-delayed loudspeakers except for 70 V ceiling-mounted loudspeakers and loudspeaker receptacles.
 - a. Belden **8477**
 - b. West Penn **227**
 - c. Approved equal
 - 3. For all ceiling-mounted loudspeaker wiring using 70-Volt lines provide color-coded #18 AWG loudspeaker wiring.
 - a. Belden **8461**
 - b. West Penn **224**
 - c. Approved equal
 - 4. Use color-coded #14 AWG conductors for all loudspeaker receptacle wiring
 - a. Belden **8473**
 - b. West Penn **226**

- C. Antenna Wiring: Provide coaxial antenna wiring for connections from wireless transmitters and receivers to antenna connection panels.
 - 1. Belden **7810A**
 - 2. Approved equal
- D. Category Wiring: Provide Category 6 8-conductor unshielded twisted pair cable with 23 AWG solid conductors and bandwidth of 250 Mhz for computer data and audio-visual transport wiring.
 - 1. Belden
 - 2. Berk-Tek
 - 3. Superior Essex
- E. Connectors: Connectors from the following manufacturers shall be considered acceptable. Install connectors appropriate for the installed cable and equipment interface.
 - 1. ADC
 - 2. Amp
 - 3. Amphenol
 - 4. Canare
 - 5. H.H. Smith
 - 6. Kings
 - 7. Neutrik
 - 8. Ponomo
 - 9. Switchcraft
 - 10. Trompeter
 - 11. Approved equal
- F. Input Connection Plates: All plates are black anodized aluminum with engraved or laser etched white lettering unless otherwise noted.
 - 1. Wall-Mounted Plates: Custom color/finish by Architect or stainless/brushed aluminum.
 - 2. Wall-Mounted Plates in Stage Areas (Behind Proscenium): Black.
 - 3. Wall-Mounted Plates at Catwalk and Overhead Areas: Black.
 - 4. Floor-Box Mounted Plates: Black.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. This specification shall include all installation and setup labor and configuration of all devices to furnish a complete, efficient, and effective system.
- B. All cables, connectors, and peripheral equipment required to attain a fully functional system shall be furnished, installed, and performed by the contractor awarded this project.
- C. Locate all apparatus requiring adjustments, cleaning, or similar attention so that it will be accessible for such attention. Equipment racks shall be positioned to permit full access for operation and service.
- D. Furnish and install brackets, braces, and supports. Minimum fastening or support safety factor shall be at least three (3). Design shall be to the approval of the Architect.

- E. All supporting structures and enclosures supplied by the Contractor not having a standard factory paint finish shall be painted. Paint specifications will be supplied by the Architect or indicated herein.
- F. Finish of blank panels and custom assembly panels shall match adjacent equipment panels.
- G. The equipment specified herein is designed to operate in environments of normal humidity, dust, and temperature. Protect equipment and related wiring where extreme environmental conditions can occur.
- H. Secure equipment firmly in place, including control panels, loudspeakers, conduit, amplifiers, racks, and cables. Make fasteners and supports to support their loads with a safety factor of at least three (3).
- I. Take precautions to prevent electromagnetic and electrostatic hum. Install equipment to provide safe operation.

3.2 CONDUIT

- A. Review and coordinate Systems conduit installation with the electrical contractor to ensure proper operation of the Systems.
- B. All wiring shall be in conduit unless authorized by the Architect, approved by the Systems Designer, and permitted by code. Exceptions are short runs at equipment terminations where there is no means of connecting conduit to the equipment.
- C. Where installed exposed, conduits shall be parallel with or at right angles to walls or ceilings and shall be supported from walls or ceilings by means of approved galvanized iron clamps or hangers. Conduit connections to equipment racks shall be insulated.
- D. Minimum size conduit shall be $\frac{3}{4}$ -inch. All conduit shall be sized for maximum forty percent (40%) fill or less if required by code.
- E. Use separate steel conduits for microphone-level circuits (below -20 dBm), line-level circuits (up to +30 dBm), loudspeaker circuits (above +30 dBm), control circuits, and power circuits. Use audio conduit which is spaced well away from power conduit. Insulate all conduit from the equipment rack(s); ground conduit only to power system ground. Do not splice lines in conduit. Connect each receptacle by an individual, insulated line to the system equipment rack.

3.3 BOXES

- A. With the exception of portable equipment, all boxes, conduits, cabinets, equipment, and related wiring shall be held in place and the mounting shall be plumb and square.
- B. All boxes shall be securely mounted to building structure. All boxes shall be installed so that wiring contained in them is accessible. Install blanking devices or threaded plugs in all unused holes.
- C. Wiring groups and circuits shall be isolated as indicated herein. Common pull or junction boxes are not permitted except as authorized, in writing, by the Systems Designer.
- D. Clean all box interiors before installing plates, panels, or covers.

3.4 WIRING METHODS AND PRACTICES

- A. Provide installation of all Systems wire and cable, ensuring proper:
 - 1. Pulling tensions.
 - 2. Quantities.
 - 3. Types.
 - 4. Lengths.
 - 5. Routing.
 - 6. Wire group separation.
 - 7. Identification.
- B. The interconnection of all equipment requiring shielded cable shall be by Belden **Type 9451**, or equivalent, unless otherwise specified.
- C. Splicing of cables is not permitted between terminations of specified equipment.
- D. Do not pull wire or cable through any box fitting or enclosure where change of raceway alignment or direction occurs; do not bend conductors to less than recommended radius. Employ temporary guides, sheaves, and rollers to protect cables from excess tension, abrasion, or damaging bending during installation.
- E. Provide wire pulling lubricants and pulling tensions in accordance with the wire and cable manufacturer's recommendations.
- F. All wires shall be permanently identified at each wire end by marking with adhesive or crimp- on markers and a chart kept of each wire's function. This applies to wire within a rack assembly as well as wire running in conduit.
- G. Wire ends should be wrapped with heat shrink tubing. Each shield or drain wire should be covered with heat shrink to avoid unintentional connections.
- H. Use ring or tongue lugs on all barrier strip terminals. Do not exceed two (2) lugs per terminal. Use crimping tools which are designed for the application or solder. Do not cut strands from conductors to fit lugs or terminals. Spare terminal blocks, equivalent to ten percent (10%) of those in actual use, shall be provided.
- I. Form, in an orderly manner, all conductors in enclosures and boxes, wire ways, and wiring troughs, providing circuit and conductor identification. Tie using tie wraps of appropriate size and type. Limit spacing between ties to 6 inches and provide circuit and conductor identification at least once in each enclosure.
- J. Provide ample service loops at each termination so that plates, panels, patch bays, and equipment can be dismounted for service and inspection.

3.5 GROUNDING

- A. Audio system wiring shall conform to the following procedures:
 - 1. Audio equipment AC ground pins shall connect to AC isolated ground.
 - 2. Audio shields between AC powered pieces of equipment shall be connected to ground at one end only. Capacitively terminate as required.
 - 3. Audio signal paths between AC powered pieces of equipment shall be connected using balanced lines and/or transformer isolation as required. No unbalanced signal paths may be connected to the patch bay.

- B. All metallic conduit, boxes and enclosures shall be grounded in accordance with the current National Electrical Code.
- C. Metallic enclosures containing active equipment shall be grounded with due regard for the minimization of electrical noise. This may include the provision of grounding conductors separate from the AC ground.

3.6 INITIAL ADJUSTMENT

- A. Verify all circuits and extensions for correct connection, continuity, and polarity. Absolute polarity shall be maintained between all points in the system.
- B. Connector polarity shall be maintained except for terminations at equipment manufactured to other standards. In the event that manufactured equipment can be ordered with, or internally set to, various standards, the equipment shall be configured as follows:
 - 1. Polarity for XLR style connector shall be: Pin 2-high, pin 3-low, and pin 1-shield.
 - 2. Polarity for TRS style connector shall be: Tip-high, ring-low, and sleeve-shield.
- C. Make all adjustments and modifications so that the system is operational.
- D. Make all adjustments and modifications for system gain structure per recommendations of major component manufacturers.

3.7 VERIFICATION TESTS

- A. Confirm that each individual wire and cable run (whether in a rack or in conduit) is identified with a unique number. These numbers are affixed to both ends of each cable and are clearly visible. Provide a complete list of these numbers along with the termination location of each end of the wire run.
- B. Confirm that all system outputs are free of spurious signals including oscillations and radio frequency signals. A wide band oscilloscope shall be used to verify this condition.
- C. Confirm that the system is free of audible clicks, pops, and other noises when any operating control is activated, with or without input signal.
- D. For all microphone lines, tie lines, return lines and effect loudspeaker lines, confirm:
 - 1. Proper circuits appearing at each termination location.
 - 2. Proper circuits appearing at each jack bay position.
 - 3. Continuity of all conductors.
 - 4. Proper polarity is maintained.
 - 5. Absence of shorts between conductors within each circuit.
 - 6. Absence of shorts between circuit conductors and conduit.
- E. Confirm that loudspeakers and mountings are free of buzzes and rattles when the loudspeaker is swept with sine wave tones over its rated bandwidth at one-half its maximum rated power.
- F. For all permanently mounted loudspeaker terminations, provide impedance measurement of each pair of loudspeaker lines with all loudspeakers connected and all amplifiers disconnected. These measurements shall be documented as editable tabular data listing impedance for each 1/3 octave band from 20 Hz to 20 kHz and shall be accurate to the nearest tenth of an Ohm.

- G. For all intercom terminations, confirm proper operation by initiating and receiving audio communication and call light.

3.8 VERIFICATION TEST REPORT

- A. Acceptance Testing shall be performed by the Systems Designer during a period designated by the Architect. Contractor shall furnish a minimum of two (2) technicians for the acceptance testing period.
- B. The minimum time required for Acceptance Testing is two (2) working days of dedicated quiet for each performance venue and recording studio and two (2) days for the classroom/rehearsal room systems. Coordinate this time period so that free access, work lighting, and electrical power are available on the site.
- C. Ensure that Systems areas are in a clean and orderly condition ready for acceptance testing.
- D. Be prepared to verify the performance of any portion of the system by demonstration, listening tests and instrumented measurements.
- E. Make additional mechanical and electrical adjustments within the scope of the work and which are deemed necessary by the Systems Designer as a result of the Acceptance Tests. This may include realigning of loudspeaker systems, changes in system gain structures, grounding, filtering, or interfaces.
- F. Final acceptance will be contingent upon issuance by the Systems Designer of a letter of acceptance stating that the work has been completed and is in accordance with the contract documents.
- G. Contractor will bear any costs incurred for additional Systems Designer's time and expenses due to failure to have the system functioning in accordance with specification requirements at the times scheduled for Systems Designer's Acceptance Testing and tuning.

3.9 COMMISSIONING OF SYSTEMS AND EQUIPMENT

- A. Engage a factory-authorized service representative or technician who is familiar with this project to participate and assist, if necessary, in the functional performance testing of the equipment include in this Division with the Commissioning Agent.

3.10 EXAMINATION

- A. Examine room conditions, ceiling and wall surfaces to assure they are in compliance with requirements, and other conditions affecting installation and operation of Interactive Whiteboards projectors and speakers.
- B. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to A/V cabling, and other conditions affecting installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.11 CLEANING

- A. Remove rubbish and debris. Installation contractor is not allowed you use the onsite dumpster and is responsible to discard their own debris off site.
- B. Clean installed items using methods and materials recommended in writing by manufacturer.

3.12 DEMONSTRATION

- A. Upon approval of the above test report by the Architect and at a mutually agreeable time, demonstrate operation of each major component and of the complete installation. After demonstration, assist as required in acceptance testes.
- B. Listening Tests: Tests will include subjective evaluation by observers listening at various positions under various operating conditions of the system, intended to test its operation in conformance with its functional requirements.
- C. Equipment Tests:
 - 1. Perform any measurements of frequency response, distortion, noise, or other characteristics and any operational tests deemed necessary by the Architect to determine conformity with these requirements.
 - 2. If the need for adjustment or modification becomes evident during demonstration and testing, continue working until the installation operates properly.
- D. Final Adjustments: Make control adjustments as directed by the Architect. Make a record of these control settings. Provide covers, caps, or shaft locks for controls not used in system operation.

3.13 COMPLETION

- A. Warranty service shall commence from one (1) year after acceptance. Warranty service shall be provided during standard business hours within 24 hours after notice of concern.
- B. Labor and materials provided under scope of project shall be covered under one (1) year warranty. Devices shall be free of defects from installation of manufacturer. If an item requires replacement, this shall be provided at no additional cost to Owner. If items are abused or rendered inoperable from misuse, they shall not be covered under said warranty.

END OF SECTION 274120

SECTION 275116 - PUBLIC ADDRESS 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. Battery backup power unit.
 - 2. Pre-amplifiers.
 - 3. Power amplifiers.
 - 4. Transfer to standby amplifier.
 - 5. Microphones.
 - 6. Volume limiter/compressor.
 - 7. Control console.
 - 8. Equipment cabinet.
 - 9. Telephone paging adapter.
 - 10. Tone generator.
 - 11. Monitor panel.
 - 12. Loudspeakers.
 - 13. Noise-operated gain controller.
 - 14. Conductors and cables.

1.3 DEFINITIONS

- A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
- B. VU: Volume unit.
- C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Power, signal, and control wiring.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Console layouts.
 - 4. Control panels.
 - 5. Calculations: For sizing backup battery.
 - 6. Wiring Diagrams: For power, signal, and control wiring.

- a. Identify terminals to facilitate installation, operation, and maintenance.
- b. Single-line diagram showing interconnection of components.
- c. Cabling diagram showing cable routing.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
- B. Qualification Data: For Installer and testing agency.
- C. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Include qualification data for testing agency.
 - 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.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For public address systems to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017700 "Closeout Procedures" and Section 017823 "Operation and Maintenance Data," include the following:
 - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - b. Operating instructions laminated and mounted adjacent to operating console location.
 - c. Training plan.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 1. Personnel certified by NICET as Audio Systems Level II Technician.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Existing public address system shall remain and be expanded as needed to support this project.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. Basis-of-Design shall be existing Bogen.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. System Functions:
 - 1. Selectively connect any zone to any available signal channel.
 - 2. Selectively control sound from microphone outlets and other inputs.
 - 3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
 - 4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
 - 5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
 - 6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components shall withstand the effects of earthquake motions determined according to Structural Specifications.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 SYSTEM DESCRIPTION

- A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
- C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with EIA/ECA-310-E.

2.5 PRE-AMPLIFIERS

- A. Pre-amplifier: Integral to power amplifier.
- B. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.

- C. Total Harmonic Distortion: Less than one percent (<1%).
- D. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.
- E. Input Jacks: Minimum of three (3). One (1) matched for low-impedance microphone; one (1) USB port; and the other matchable to DVD or CD player, or radio tuner signals without external adapters.
- F. Minimum Noise Level: Minus 55 dB below rated output.
- G. Controls: On-off, input levels, and master gain.

2.6 POWER AMPLIFIERS

- A. Mounting: Console.
- B. Output Power: 70-V balanced line. Eighty percent (80%) of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus a ten percent (10%) allowance for future stations.
- C. Total Harmonic Distortion: Less than three percent (<3%) at rated power output from 50 to 12,000 Hz.
- D. Minimum Signal-to-Noise Ratio: 80 dB, at rated output.
- E. Frequency Response: Within plus or minus 3 dB from 20 to 12,000 Hz.
- F. Output Regulation: Less than 2 dB from full to no load.
- G. Controls: On-off, input levels, and low-cut filter.
- H. Input Sensitivity: Matched to pre-amplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.7 MICROPHONES

- A. Paging Microphone:
 - 1. Type: Dynamic, with cardioid polar characteristic.
 - 2. Impedance: 250 ohms.
 - 3. Frequency Response: Uniform, 50 to 15,000 Hz.
 - 4. Sensitivity: Minus 70 dB.
 - 5. Output Level: Minus 58 dB, minimum.
 - 6. Cable: Braided shield cable with Amphenol XLR connectors. Coordinate impedance with microphone impedance.
 - 7. Mounting: Desk stand with integral-locking, press-to-talk switch.

2.8 VOLUME LIMITER/COMPRESSOR

- A. Minimum Performance Requirements:
 - 1. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
 - 2. Reduction Ratio: Automatically vary compression ratio, and attack and release times for voice and music inputs.

- a. Compression Ratio Range: 3:1 to 10:1 minimum.
 - b. Averaging Compressor Attack Time: Up to 500 milliseconds.
 - c. Signal Fast Compression Attack Time: Less than 10 milliseconds.
 - d. Release time: Up to 500 milliseconds.
3. Distortion: 0.5 percent, maximum.
 4. Rated Output: Minimum of plus 14 dB.
 5. Inputs: Minimum of two (2) inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.

2.9 EQUIPMENT CABINET

- A. Comply with EIA/ECA-310-E.
- B. House amplifiers and auxiliary equipment at each location.
- C. Cabinet Housing:
 1. Constructed of 0.0478-inch steel, minimum, with front-locking doors and standard EIA/ECA-310-E-compliant, 19-inch racks.
 2. Arranged for floor or wall mounting as indicated.
 3. Sized to house all equipment indicated, plus spare capacity.
 4. Include twenty percent (20%) minimum spare capacity for future equipment in addition to space required for future equipment.
- D. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.
- E. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

2.10 TELEPHONE PAGING ADAPTER

- A. Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for pre-selected zones.
 1. Minimum Frequency Response: Flat, 200 to 2500 Hz.
 2. Impedance Matching: Adapter matches telephone line to public address equipment input.
 3. Cabinet mounted.

2.11 TONE GENERATOR

- A. Tone generator shall provide clock and program interface with public address system.
- B. Signals: Minimum of seven (7) distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.
- C. Pitch Control: Chimes and tone.
- D. Volume Control: All outputs.
- E. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.

- F. Mounting: Cabinet.

2.12 MONITOR PANEL

- A. Monitor power amplifiers.
- B. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.
- C. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.
- D. Mounting: Cabinet.

2.13 LOUDSPEAKERS

- A. Cone-Type Loudspeakers:

1. Minimum Axial Sensitivity: 91 dB at 1 m, with 1-W input.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
4. Rated Output Level: 10 W.
5. Minimum Dispersion Angle: 100 degrees.
6. Matching Transformer: Full-power rated with four (4) taps. Maximum insertion loss of 0.5 dB.
7. Surface-Mounted Units: Ceiling, wall, or pendant mounted, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting.
8. Flush-Ceiling-Mounted Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel.

- B. Horn-Type Loudspeakers:

1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
3. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
4. Dispersion Angle: 130 by 110 degrees.
5. Mounting: Integral bracket.
6. Units in Damp, Wet, or Outdoor Locations: Listed and labeled for environment in which they are located.

2.14 OUTLETS

- A. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.
 1. Wattage Rating: 10 W unless otherwise indicated.
 2. Attenuation per Step: 3 dB, with positive off position.
 3. Insertion Loss: 0.4 dB maximum.
 4. Attenuation Bypass Relay: SPDT. Connected to operate and bypass attenuation when all-call, paging, program signal, or pre-recorded message features are used. Relay returns to normal position at end of priority transmission.
 5. Label: "PA Volume."

- B. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.
- C. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.

2.15 BATTERY BACKUP POWER UNIT

- A. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for 1 hour of continuous full operation.
- B. Unit shall supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.
- C. Battery shall be on float charge when not supplying system and able to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.
- D. Unit shall automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

2.16 CONDUCTORS AND CABLES

- A. Jacketed, twisted pair and twisted multi-pair, untinned solid copper.
 - 1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32-inch-thick.
 - 2. Microphone Cables: Neoprene jacketed, not less than 2/64-inch-thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than sixty percent (60%).
 - 3. Plenum Cable: Listed and labeled for plenum installation.

2.17 PATHWAYS

- A. Conduit and Boxes: Comply with Section 270528 "Pathways for Communications Systems."
 - 1. Outlet boxes shall be not less than 2 inches wide, 3 inches high, and 2½ inches deep.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method:
 - 1. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.

- b. Comply with requirements for pathways and boxes specified in Section 270528 "Pathways for Communications Systems."

- 2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements in Section 270528 "Pathways for Communications Systems." for installation of conduits and wireways.
- B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Cable Installation Requirements:
 - 1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
 - 2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
 - 3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
 - 5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
- C. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
 - 3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
- D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

- A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

- B. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- C. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- D. Equipment Cabinets and Racks:
 - 1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
 - 2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
 - 3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
- E. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.
- F. Wall-Mounted Outlets: Flush mounted.
- G. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.
- H. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
- I. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- J. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.
- K. Connect wiring according to Section 271500 "Communications Horizontal Cabling".

3.5 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:

1. Schedule tests with at least seven (7) days' advance notice of test performance.
 2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
 3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, pre-amplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
 4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
 - a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
 - b. Repeat test for each separately controlled zone of loudspeakers.
 - c. Minimum acceptance ratio is 50 dB.
 5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each pre-amplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is three percent (3%) total harmonics.
 6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five (5) locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
 7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
 8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground.
- C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
- D. Public address system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.
- 3.7 STARTUP SERVICE
- A. Engage a factory-authorized service representative to perform startup service.
1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
 2. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

- A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.
- B. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 275116

SECTION 283100 - INTEGRATED SECURITY 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. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
2. Video surveillance additions to existing Avigilon system.
3. Access control additions to existing Avigilon system.
4. Integration of other electronic and electrical systems and equipment.

B. Related Sections:

1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for power cabling between master control units and field-mounted devices and control units.
2. Section 271300 "Communications Backbone Cabling" for Category 6 backbone (riser-rated) cabling.
3. Section 271500 "Communications Horizontal Cabling" for Category 5e, 6, and 7 horizontal (general use, riser-, and plenum-rated) cabling.

1.3 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. PIR: Passive infrared.
- C. RFI: Radio-frequency interference.
- D. UPS: Uninterruptible power supply.
- E. Control Unit: System component that monitors inputs and controls outputs through various circuits.
- F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
- G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
- H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

- I. Standard Intruder: A person who weighs 100 pounds or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes.
- J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
- K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
- L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.4 ACTION SUBMITTALS

- A. Product Data: Components for sensing, detecting, access control, video surveillance, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
 - 2. UPS: Sizing calculations.
 - 3. Device Address List: Coordinate with final system programming.
 - 4. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
 - 5. Details of surge-protection devices and their installation.
 - 6. Sensor detection patterns and adjustment ranges.
- B. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, intrusion detection systems integrator and testing agency.
- B. Field quality-control reports.
 - 1. Anchor inspection reports documenting inspections of built-in and cast-in anchors.
- C. Product Warranty: Sample of special warranty.
- D. Field Test Reports: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within sixty (60) days of date of Contract award.
- E. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Data for each type of product, including features and operating sequences, both automatic and manual.
 - 2. Master control-unit hardware and software data.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Intrusion Detection Devices: Furnish quantity equal to five percent (5%) of the number of units of each type installed, but no fewer than one (1) of each type.
 - 2. Security Fasteners: Furnish no fewer than one (1) box for every fifty (50) boxes or fraction thereof, of each type and size of security fastener installed.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
 - 2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 3. Layout Responsibility: Preparation of Shop Drawings and field testing program development by an RCDD Technician.
 - 4. Installation Supervision: Installation shall be under the direct supervision of Level 2 Commercial Installer, who shall be present at all times when Work of this Section is performed at Project site.
- B. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
 - 1. At least one (1) of whom is a Certified Systems Integrator.

1.9 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F and a relative humidity of twenty to eighty percent (20-80%), non-condensing.
 - 2. Interior, Controlled Environment: System components, except master control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambients of 36 to 122 deg F dry bulb and twenty to ninety percent (20-90%) relative humidity, non-condensing.
 - 3. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambients of 0 to 122 deg F dry bulb and twenty to ninety percent (20-90%) relative humidity, non-condensing.

4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of minus 30 to plus 122 deg F dry bulb and twenty to ninety percent (20-90%) relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 105 mph.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

1.10 WARRANTY

- A. Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
 1. Provide manufacturer's standard warranty from the date of substantial completion, or a one (1) year warranty, from the date of substantial completion, whichever is greater.

PART 2 - PRODUCTS

2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Description: Hard-wired, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.
- B. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
 1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
 2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
 3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.
- C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.
- D. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
- E. Operator Commands:
 1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
 2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
 3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
 4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.

5. Protected Zone Test: Initiate operational test of a specific protected zone.
 6. System Test: Initiate system-wide operational test.
 7. Print reports.
- F. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:
1. Switch selected lights.
 2. Open a signal path between certain intercommunication stations.
 3. Shift sound system to "listening mode" and open a signal path to certain system speakers.
 4. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.
- G. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.
- H. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
- I. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be pre-set for repetitive, daily, and weekly; specially scheduled operations may be pre-set up to a year in advance. Manual secure-access control stations shall override programmed settings.
- J. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.2 SYSTEM COMPONENT REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.
- C. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.
- D. Comply with NFPA 70.
- E. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
 1. Door hardware specified in Section 087100 "Door Hardware."
 2. Lighting controls specified in Section 260923 "Lighting Control Devices."
 3. Intercom and program systems (match existing components)
 4. Public address and mass notification systems specified in Section 275116 "Public Address Systems."
 5. Access control system (match existing components).

6. Fire alarm system specified in Section 283111 "Digital, Addressable Fire-Alarm System."
7. Video surveillance system specified in this specification.

F. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

G. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

H. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

I. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

J. Anti-masking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

K. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

2.3 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping non-corrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, stainless-steel.

D. Corrosion Resistant: NEMA 250, Type 4X, stainless-steel.

E. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.4 SECURE AND ACCESS DEVICES

A. System shall match manufacture of existing system.

B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

C. Key-Operated Switch: Change protected zone between secure and access conditions.

2.5 DOOR AND WINDOW SWITCHES

- A. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to eighty percent (80%) of switch capacity. Bias magnet and minimum of two (2) encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.
- B. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.
- C. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

2.6 DURESS-ALARM SWITCHES

- A. Description: A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master control unit, with no visible or audible indication when activated. Switch shall lock in activated position until reset with a key.
 - 1. Minimum Switch Rating: 50,000 operations.
 - 2. Foot Rail: Foot activated, floor mounting.
 - 3. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

2.7 MASTER CONTROL UNIT

- A. System is existing all new components shall be manufactured by same manufacturer as the existing.
- B. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
 - 1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - 2. Include a real-time clock for time annotation of events on the event recorder and printer.
 - 3. Addressable initiation devices that communicate device identity and status.
 - 4. Control circuits for operation of mechanical equipment in response to an alarm.
- C. Construction: Wall mounted equipment rack, modular, with separate and independent alarm and supervisory system modules. Arrangements that require removal of field wiring for module replacement are unacceptable.
- D. Comply with UL 609.
- E. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: LCD, three (3) lines of forty (40) characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
 - 3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event.

- Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
 4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
 5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
 - a. Acknowledge alarm.
 - b. Silence alarm.
 - c. System reset.
 - d. LED test.
 6. Timing Unit: Solid state, programmable, three hundred sixty-five (365) days.
 7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
 8. Alarm Indication: Audible signal sounds and an LED lights at master control unit identifying the addressable detector originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
 9. Alarm activation sounds a bell or siren and strobe.
- F. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a twenty percent (20%) increase in load.
- G. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1-inch-high. Identify, with permanent labels, individual components and modules within cabinets.
- H. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
- I. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- 2.8 AUDIBLE AND VISUAL ALARM DEVICES
- A. Bell: 10 inches in diameter, rated to produce a minimum sound output of 84 dB at 10 feet from master control unit.
1. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

- B. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet, plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: 2 minutes on and 5 minutes off.
 - 1. Designed for use in industrial areas and in high-noise, severe-weather marine environments.
- C. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.
 - 1. Light Output: 115 cd, minimum.
 - 2. Flash Rate: 60 per minute.

2.9 VIDEO SURVEILLANCE COMPONENTS

- A. All components of the video surveillance system expansion must be compatible and listed for operation with the existing Avigilon system.
- B. IP Cameras shall be manufactured by Avigilon, Axis, or Bosch subject to all other requirements of this specification. Basis-of-Design – **Avigilon H6A**
 - 1. All associated devices and/or licensing is required to obtain a fully functional system, as mandated by this bid specification.
 - 2. All camera locations MUST be field verified with the Owner prior to start of project. Architectural drawings are for approximation purposes only. Additional charges will not be allowed for installation in areas not reviewed or approved by the Owner.
 - 3. Interior fixed color camera: 6 Megapixel, H.264 HDSM, multi-stream with polycarbonate vandal resistant housing.

2.10 ACCESS CONTROL COMPONENTS

- A. All components of the access control system expansion must be compatible and listed for operation with the existing system.
 - 1. Card readers shall match the style and configuration of the existing system.
 - 2. Contractor is responsible for surveying the existing system capacity and furnishing all components required for the expansion shown. Expansion modules for the added card readers shall be assumed. All necessary programming of the existing system shall be provided.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

- D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.
 - 1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
 - 2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
- E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INTEGRATION

- A. Integrate intrusion detection system with the following systems and equipment:
 - 1. Electronic door hardware.
 - 2. Network lighting controls.
 - 3. Intercommunications and program systems.
 - 4. Public address and mass notification systems.
 - 5. Access control.
 - 6. Fire-alarm system.
 - 7. Perimeter security system.
 - 8. Video surveillance.

3.3 SYSTEM INSTALLATION

- A. Comply with UL 681 and NFPA 731.
- B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
- C. Connecting to Existing Equipment: Verify that existing video surveillance and access control systems are operational before making changes or connections.
 - 1. Connect new equipment to existing control panel in existing part of the building.
 - 2. Connect new equipment to existing monitoring equipment at the Supervising Station.
 - 3. Expand, modify, and supplement existing monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

3.4 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be ½-inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to

sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
4. Data and Television Signal Transmission Cables: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

G. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products per owners standards.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements per owners standards.

B. Install instructions frame in a location visible from master control unit.

3.6 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.

3.7 FIELD QUALITY CONTROL

A. Pre-testing: After installation, align, adjust, and balance system and perform complete pre-testing to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pre-testing: After pre-testing is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
 - B. 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.
 - C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
 1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
 2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
 - D. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."
 - E. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.
- 3.8 ADJUSTING
- A. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three (3) visits to Project during other-than-normal occupancy hours for this purpose.
- 3.9 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 283100

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Heat detectors.
 - 5. Carbon monoxide detectors.
 - 6. Notification appliances.
 - 7. Remote annunciator.
 - 8. Addressable interface device.
 - 9. Digital alarm communicator transmitter.
 - 10. Radio alarm transmitter.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

- A. Non-coded addressable system, with automatic sensitivity control of certain smoke detectors and multi-plexed signal transmission, dedicated to fire-alarm service only.

1.5 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."

1.6 SUBMITTALS

- A. General Submittal Requirements:
 - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 - 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.

- b. NICET-certified fire-alarm technician, Level III and/or Level IV minimum.
 - c. Licensed or certified by authorities having jurisdiction.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 2. Include voltage drop calculations for notification appliance circuits.
 - 3. Include battery-size calculations.
 - 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 - 6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 - 7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- D. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
 - 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
- E. Qualification Data: For qualified Installer.
- F. Seismic Qualification Certificates: For fire-alarm control unit, 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.
- G. Field quality-control reports.
- H. Operation and Maintenance Data: For fire-alarm systems and components to include in operation and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25.

I. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. NFPA Certification: Obtain certification according to NFPA 72

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 1. Notify Architect and Construction Manager no fewer than five (5) days in advance of proposed interruption of fire-alarm service.
 2. Do not proceed with interruption of fire-alarm service without Architect and Construction Manager written permission.

1.9 SEQUENCING AND SCHEDULING

- A. The system alarm operation subsequent to the alarm activation of any manual pull station, sprinkler flow switch, hood suppression system or automatic detection device is to be in accordance with Article 2.2 of this specification.

B. Alarm Verification:

1. The activation of any system smoke detector shall initiate an Alarm Verification operation whereby the panel will reset the activated detector and wait for a second alarm activation.
2. If, within 1 minute after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described previously.
3. If no second alarm occurs within one minute the system shall resume normal operation.
4. The Alarm Verification is to operate only on smoke detector alarms. Other activated initiating devices shall be processed immediately.
5. The alarm verification operation is to be selectable by addressable device.
6. The control Unit shall have the capability to display the number of times (tally) a device has gone into a verification mode. Should this smoke verification tally reach a pre-programmed number, a trouble condition shall occur.

C. Supervisory Service:

1. The control panel shall have a dedicated supervisory service condition and a dedicated supervisory service acknowledge switch.
2. Activating the Supervisory Service Acknowledge Switch will silence the supervisory audible signal while maintaining the Supervisory Service listing on indicating the tamper contact is still in the off-normal state.
3. Restoring the valve to the normal position shall cause the Supervisory Service indication to reset thus indicating restoration to normal position.
4. Restoring the valve to the normal position shall cause the supervisory service audible signal to pulse thus indicating restoration to normal position.
5. Activating the Supervisory Service Acknowledge Switch will silence the audible signal and restore the system to normal.

D. A manual evacuation switch shall be provided to operate system alarm indicating appliances. Other control circuits shall not be activated. However, an actual alarm shall be processed as described previously.

E. Activation of an auxiliary bypass switch shall override the automatic functions either selectively or throughout the system.

F. Alarm and trouble conditions shall be immediately displayed on the control panel front.

1.10 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide thirty (30) days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.11 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps for Strobe Units: Quantity equal to ten percent (10%) of amount installed, but no fewer than one (1) unit.
 - 2. Smoke Detectors and Heat Detectors: Quantity equal to ten percent (10%) of amount of each type installed, but no fewer than one (1) unit of each type.
 - 3. Detector Bases: Quantity equal to two percent (2%) of amount of each type installed, but no fewer than one (1) unit of each type.
 - 4. Keys and Tools: One (1) extra set for access to locked and tamper-proofed components.
 - 5. Audible and Visual Notification Appliances: One (1) of each type installed.
 - 6. Fuses: Two (2) of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All new fire alarm components shall be by the same manufacturer as the existing system (**Edwards EST 3**), no exceptions.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one (1) or more of the following devices and systems:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Verified automatic alarm operation of smoke detectors.
 - 6. Automatic sprinkler system water flow and pressure.
- B. Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm visual notification appliances until extinguished by the Alarm Reset Switch.
 - 2. Identify alarm at fire-alarm control unit and remote annunciators.
 - 3. Transmit an alarm signal to the remote alarm receiving station.
 - 4. Release fire and smoke doors held open by magnetic door holders.
 - 5. Activate voice/alarm communication system until silenced by the alarm silence switch or individual circuit switch at the control panel.
 - 6. From an interface with the local systems, the fire alarm system shall mute the sound/paging systems during an alarm.
 - 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 - 8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 9. Recall elevators to primary or alternate recall floors.
 - 10. Activate emergency shutoffs for gas and fuel supplies.
 - 11. Record events in the system memory.
- C. Supervisory signal initiation shall be by one (1) or more of the following devices and actions:
 - 1. Valve supervisory switch.
 - 2. Low-air-pressure switch of a dry-pipe sprinkler system.

3. Generator general alarm switch.
4. Carbon monoxide detector.

D. System trouble signal initiation shall be by one (1) or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, two (2) lines of forty (40) characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.

- a. Initiating Device Circuits: Style B.
 - b. Notification Appliance Circuits: Style Y.
 - c. Signaling Line Circuits: Style 3.
 - d. Install no more than fifty (50) addressable devices on each signaling line circuit.
2. Serial Interfaces: Two (2) RS-232 ports for printers.
- D. Smoke-Alarm Verification:
 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
 3. Sound general alarm if the alarm is verified.
 4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- E. Notification Appliance Circuit: Operation shall sound with an initial alert tone, followed by a pre-recorded emergency voice message of approximately 15 seconds, followed by a repeating alarm "whoop" tone.
- F. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 1. Alarm current draw of entire fire-alarm system shall not exceed eighty percent (80%) of the power-supply module rating.
- J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.
 2. System shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 60 hours with 5 minutes of alarm operation at the end of this period.
- K. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 2. Station Reset: Key operated switch.
 3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
 4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
 2. Detectors shall be two-wire type.
 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
 7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Provide multiple levels of detection sensitivity for each sensor.
- B. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
7. Remote Test Switch: With keyed switch and LED indicator.

2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 CARBON MONOXIDE DETECTORS

- A. General Requirements for System-type Carbon Monoxide Detectors:
1. Comply with UL 2075 and UL 2034; operating at 24-V dc, nominal.

2. Electrochemical sensing technology.
3. Detectors shall be two-wire type.
4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

- B. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

2.8 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

- C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output: 15/30/75/110 cd, selectable in the field.
2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

- D. Voice/Tone Notification Appliances (Speakers):

1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
4. Mounting: Flush.
5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.9 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two (2) telephone lines and dial a pre-set number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on one (1) of the lines is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply or loss of power.
 - 5. Low battery.
 - 6. Abnormal test signal.
 - 7. Communication bus failure.
- E. Control panel and NAC panel shall receive 120 VAC power via a dedicated branch circuit protected in accordance with the National Electric Code.
 - 1. The system shall support one hundred percent (100%) of notification and initiating devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
 - 2. System shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 60 hours with 5 minutes of alarm operation at the end of this period. Any system cabinets furnished with independent power supplies and/or batteries shall also meet these requirements.
 - 3. System shall automatically transfer to standby batteries upon power failure. All battery charging and recharging operations shall be automatic.

4. All circuits requiring system operating power shall be 24 VDC and shall be individually fused or equivalently protected at the control unit.
5. The incoming power to the system shall be supervised so that any power failure must be audibly and visibly indicated at the control unit and the annunciator. A green "power on" LED shall be displayed continuously while incoming power is present.
6. If a "LOW BATTERY" condition is left unattended a second stage "DEPLETED BATTERY" trouble condition shall be audibly and visibly reported at the control unit indicating the batteries are below the listed system operating voltage.
7. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visibly indicated at the control unit and the annunciator.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.
2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 COMMISSIONING OF SYSTEMS AND EQUIPMENT

A. Engage a factory-authorized service representative or technician who is familiar with this project to participate and assist, if necessary, in the functional performance testing of the equipment include in this Division with the Commissioning Agent.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install fire-alarm control unit on wall with tops of cabinets not more than 72 inches above the finished floor.

C. Smoke- or Heat-Detector Spacing:

1. Smooth ceiling spacing shall not exceed 30 feet.
2. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
3. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
4. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

E. Carbon Monoxide Detectors: Comply with NFPA 720. Install per manufacturer's instructions and as remotely located from the heating appliance as possible (within room). Detectors shall be individually addressably monitored and programmed to initiate a supervisory signal.

- F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.
- I. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- J. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.3 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated air-conditioning duct systems.
 - 2. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 3. Supervisory connections at valve supervisory switches.
 - 4. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. 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.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 3. Test carbon monoxide detectors in accordance with NFPA 720.
 4. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 5. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 6. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 7. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- H. Annual Test and Inspection: One (1) year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 DEMONSTRATION

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

END OF SECTION 283111