

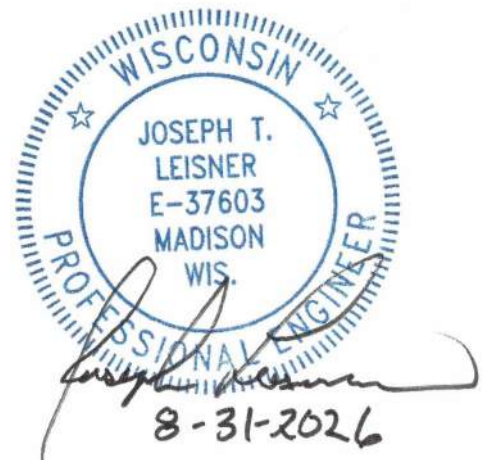


PROJECT MANUAL FOR
SAUK COUNTY COURTHOUSE
HVAC AND LIGHTING UPGRADES
CONSTRUCTION DOCUMENT ISSUANCE

515 OAK STREET
BARABOO WISCONSIN
STRANG PROJECT NO. 2025012
AUGUST 31, 2026



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SECTION 00 01 03 - PROJECT DIRECTORY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Identification of project team members and their contact information.

1.02 OWNER:

- A. Name: Sauk County.

1.03 CONSULTANTS:

- A. Architect: Design Professional of Record. All correspondence from the Contractor regarding construction documents authored by Architect's consultants will be through this party, unless alternate arrangements are mutually agreed upon at preconstruction meeting.

1. Company Name: Strang, Inc.
 - a. Address Line 1: 811 East Washington Avenue, Suite 200.
 - b. City: Madison.
 - c. State: WI.
 - d. Zip Code: 53703.
 - e. Telephone: 608-276-9200.

- B. Structural Engineering Consultant:

1. Company Name: Core 4 Engineering, Inc..
 - a. Address Line 1: N70 W5185 Columbia Road.
 - b. City: Cedarburg.
 - c. State: WI.
 - d. Zip Code: 53012.
 - e. Telephone: 262-236-9372.

- C. Mechanical Engineering Consultant - HVAC:

1. Company Name: Strang, Inc..
 - a. Address Line 1: 811 East Washington Avenue, Suite 200.
 - b. City: Madison.
 - c. State: WI.
 - d. Zip Code: 53703.
 - e. Telephone: 608-276-9200.

- D. Electrical Engineering Consultant:

1. Company Name: Strang, Inc..
 - a. Address Line 1: 811 East Washington Avenue, Suite 200.
 - b. City: Madison.
 - c. State: WI.

Sauk County Courthouse HVAC and Lighting Upgrades
Project No. 2025012

- d. Zip Code: 53703.
- e. Telephone: 608-276-9200.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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END OF SECTION

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REQUEST FOR BIDS

Sauk County Building Services

SAUK COUNTY COURTHOUSE HVAC and LIGHTING UPGRADES PROJECT

Wednesday, September 9, 2026

- I. Point of contact: Ian Crammond
Sauk County Building Services
510 Broadway
Baraboo, Wisconsin 53913
(608) 355-4415
- II. Proposal Due Date: Bids must be received, and date stamped no later than 10:00 AM Central Standard Time, October 29th, 2026. Faxes, email or electronic submissions are not acceptable. Bids or amendments received by Sauk County after that time will not be considered. Public Opening of Bids will be conducted at the Sauk County Courthouse – EMBS Meeting Room(C128) at 10:10AM, Thursday, October 29th, 2026 at 510 Broadway, Baraboo, Wisconsin 53913.

III. **ALL PROPOSALS MUST BE ADDRESSED TO:**

**Sauk County Clerk
Sauk County West Square Building
505 Broadway
Baraboo, Wisconsin 53913**

The words **Sauk County Courthouse HVAC and Lighting Upgrades Project Bid** must be marked on the sealed envelope.

PART ONE
INTRODUCTION AND GENERAL INFORMATION

1.0 INTRODUCTION

- 1.1 This document constitutes a request for sealed Bids from qualified vendors to complete the **Sauk County Courthouse HVAC and Lighting Upgrades Project Bid** at the Sauk County Courthouse Building at 510 Broadway Baraboo, Wisconsin.

2.0 ORGANIZATION

- 2.1 This document, referred to as a Request for Bids (RFB), has been divided into the following parts for the convenience of the contractor:
- Part One - Introduction and General Information
 - Part Two- - Scope of work
 - Part Three - General Requirement - Standard Terms & Conditions
 - Part Four - Evaluation Information
 - Part Five - Pricing & Information

3.0 DEFINITIONS

- 3.1 For the purpose of this RFB the Vendor will be referred to as Vendor and Sauk County will be referred to as County. See additional definitions for Contract Documents in Section 01 42 16.

4.0 BACKGROUND INFORMATION

- 4.1 Sauk County is one of 72 units of county government in the State of Wisconsin and is a municipal corporation existing pursuant to the authority of Chapter 59 of the Wisconsin Statutes. County operations currently include a skilled nursing facility, a human services department, a law enforcement agency, a state circuit court system, a highway department, a tax administration and collection effort, and other government related functions.

5.0 TENTATIVE SCHEDULE OF EVENTS

<i>EVENT</i>	<i>DATE</i>	<i>TIME</i>
Request for Bid released	September 9, 2026	
Mandatory Site visit	September 24, 2026	1:00 pm
Questions Due	October 16, 2026	4:00 pm
Response to Bidders Questions	October 20, 2026	
Bids Due	October 29, 2026	10:00 AM
Bids opened	October 29, 2026	10:10 AM
Approve resolution awarding contract	November 4, 2026	4:30 PM

Questions regarding the project can be sent to Ian Crammond at ian.crammond@saukcountywi.gov

* Responses to all questions to be e-mailed, Bid vendors shall provide an email address to Ian Crammond at the above referenced email address in order to receive said updates.

INSPECTION REQUIREMENT

Sauk County will be having a site visit for this to fully understand this project. The Site visit will commence at 1:00 p.m. on September 24, 2026 at the Sauk County Courthouse, EMBS Meeting Room (C128) at 510 Broadway, Baraboo, WI 53913.

6.0 AMENDMENTS AND QUESTIONS:

- 6.1 Sauk County reserves the right to modify this RFB prior to the Proposal due date. Such modifications will be issued by Amendment to all RFB holders.
- 6.2 If Amendments are of such a nature as to require substantive changes in the scope of work or Bid price, the Bid due date may be postponed by such a time that will enable vendor to revise their Bids. In such cases, the Amendment will include an announcement of the new Bid due date.
- 6.3 Interpretations or clarifications in response to questions received prior to the Bid due date may be issued by Addenda to all parties recorded as having received this RFB, if considered necessary by the County.
- 6.4 Questions received after the Question due date of October 16, 2026 may not be answered.
- 6.5 Only formal written responses to questions issued by letter or addenda are binding. Oral and other interpretations or clarifications are not binding.

7.0 CONTRACT

- 7.1 Sauk County intends to award one contract for all work described in this Request for Bids.
- 7.2 Contract type shall be a single fixed-priced (lump sum) contract.

8.0 CONTACT INFORMATION

- 8.1 Each vendor obtaining a copy of this Request for Bid either in person, via the Sauk County Web Site, or by other means, must submit an email to ian.crammond@saukcountywi.gov that contains the Vendor name & contact information. This will ensure that any Addenda, questions/answers or other information related to this Request for Bid is received by all interested bidders. If this information is not submitted five (5) business days prior to the Due Date of this Bid, the County retains the right to reject the bid solely for this reason or accept the bid.

PART TWO
SCOPE OF WORK

1.0 OVERVIEW

Work of this Project consists of updates to Lighting, HVAC and controls systems. This includes, but is not limited to selective building demolition, excavation, concrete structures, ceilings and related electrical work.

2.0 SCHEDULE

The work included in this request for proposal shall be substantially completed by **July 1st, 2027**

3.0 REFERENCES

The Bid shall list three references for similar work completed by the Proposer.

4.0 PROPOSAL

This Request for Bid in its entirety shall be returned with signatures as noted along with all other requested information. Failure to do so will be cause to reject the bid.

PART THREE
GENERAL REQUIREMENTS

STANDARD TERMS AND CONDITIONS

- 1.0** **N/A.**
- 2.0** **N/A.**
- 3.0** **QUANTITIES:** The quantities shown on this request are based on estimated needs. The County reserves the right to increase or decrease quantities to meet actual needs.
- 4.0** **PRICING AND DISCOUNT:** Sauk County qualifies for governmental discounts; unit prices shall reflect these discounts.
- 5.0** **ACCEPTANCE-REJECTION:** Sauk County reserves the right to accept or reject any or all Bid, to waive any technicality in any Bid submitted, and to accept any part of a Bid as deemed to be in the best interests of Sauk County.
- 5.1 Bids **MUST** be date stamped by Sauk County Clerk, 505 Broadway, Room 144, Baraboo, WI 53913, on or before the date and time that the Bid is due. Bids dated and time stamped in another office will be rejected. Receipt of a Bid by the mail system does not constitute receipt of a Bid by the County Clerk's office.
- 5.2 Bids shall be submitted on company letterhead and signed by an officer of the company. Mark sealed envelope: " **Sauk County Courthouse HVAC and Lighting Upgrades Project Bid** " alongside the County's address information.
- 7.0** **N/A.**
- 8.0** **PAYMENT TERMS:** Payment terms shall be specified in the proposal documents. Sauk County shall have 45 days from the date of invoice to make payments required under the proposal.
- 9.0** **TAXES:** Sauk County and its agencies are exempt from payment of all federal tax and Wisconsin state and Local taxes on its purchases except Wisconsin excise tax as described below which is excepted by State Statutes.
- 9.1 Sauk County, including all its agencies, is required to pay the Wisconsin excise or occupation tax on its purchase of beer, liquor, wine, cigarettes, tobacco products, motor vehicle fuel, and general aviation fuel. However, it is exempt from payment of Wisconsin sales or use tax on its purchases. Sauk County may be subject to other states' taxes on its purchases in that state depending on the laws of that state.
- 10.0** **ENTIRE AGREEMENT:** These Standard Terms and Conditions shall apply to any contract or order awarded as a result of this request except where special requirements are stated elsewhere in the request; in such cases, the special requirements shall apply. Further, the written contract and/or order with referenced parts and attachments shall constitute the entire agreement and no other terms and conditions in any document, acceptance, or acknowledgment shall be effective or binding unless expressly agreed to in writing by the contracting authority. The successful Bid/bidder will be required to sign the contract document referenced hereto.
- 11.0** **GUARANTEED DELIVERY:** Failure of the vendor to adhere to delivery schedules as specified or to promptly replace rejected materials shall render the vendor liable for all costs in excess of the contract price when alternate procurement is necessary. Excess costs shall include the administrative costs.
- 12.0** **N/A.**

- 13.0 ANTITRUST ASSIGNMENT:** The vendor and Sauk County recognize that in actual economic practice, overcharges resulting from antitrust violations are in fact usually borne by Sauk County (purchaser). Therefore, vendor hereby assigns to Sauk County any and all claims for such overcharges as to goods, materials or services.
- 14.0 ASSIGNMENT:** No right or duty in whole or in part of the vendor under this contract may be assigned or delegated without the prior written consent of Sauk County.
- 15.0 N/A.**
- 16.0 N/A.**
- 17.0 NONDISCRIMINATION:** In connection with the performance of work under this contract, the vendor agrees not to discriminate against any employee or applicant for employment because of age, race religion, color, handicap, sex, physical condition, sexual orientation, national origin, or developmental disability, as defined in s. 51.01(5), Wis. Stats. This provision shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; lay-off or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.
- 17.1 Failure to comply with the conditions of this clause may result in the vendor becoming declared an "ineligible" vendor, termination of the contract, or withholding of payment.
- 18.0 SAFETY REQUIREMENTS:** All employer practices, employee practices, materials, equipment, and supplies provided to Sauk County must comply fully with all safety requirements as set forth by the Wisconsin Administrative Code, Rules of the Industrial Commission on Safety, and all applicable OSHA Standards.
- 19.0 N/A.**
- 20.0 N/A.**
- 21.0 INSURANCE RESPONSIBILITY:** The vendor performing services for Sauk County shall:
- N/A.
- 21.1 Maintain insurance as indicated in the Supplementary Conditions.
- 21.2 Provide insurance certificates indicating required coverage, countersigned by an insurer licensed to do business in Wisconsin, covering the period of the agreement/contract. The insurance certificate is required to be presented prior to the issuance of the purchase order or before commencement of the contract.
- 22.0 CANCELLATION:** Sauk County reserves the right to cancel any contract in whole or in part without penalty due to non-appropriation of funds, or for failure of the vendor to comply with the terms, conditions, and specifications of this contract.
- 23.0 N/A.**
- 24.0 DATE OF COMPLETION:** Sauk County requires that all work under this contract shall be completed by the date of completion stated in the bid. Consideration will be given to time of completion when reviewing the submitted bids. In order to be considered a responsive bid, the bid must state a date of completion.
- 25.0 N/A.**
- 26.0 AUDIT:** During the term of the contract, the vendor shall, upon the request of the Sauk County Controller, make available at reasonable times and places, such information as may be required for the purpose of auditing submitted bills for the service provided under the contract.
- 27.0 INDEPENDENT VENDOR STATUS:** None of the officers, employees, or agents of the vendor are employees of Sauk County for any purpose, including but not limited to compensation, fringe benefits, or insurance coverage.

- 28.0 PUBLIC RECORDS ACCESS:** It is the intention of the county to maintain an open and public process in the solicitation, submission, review, and approval of procurement activities.
- 28.1 Bid openings are public unless otherwise specified. Records may not be available for public inspection prior to issuance of the notice of intent to award or the award of the contract.
- 28.2 If awarded this contract, Vendor shall assist Sauk county in complying with any open records request.
- 29.0 PROPRIETARY INFORMATION:** Any restrictions on the use of data contained within a request must be clearly stated in the Bid itself. Proprietary information submitted in response to a request will be handled in accordance with applicable Sauk County procurement regulations and the Wisconsin public records law. Proprietary restrictions normally are not accepted. However, when accepted, it is the vendor's responsibility to defend the determination in the event of an appeal or litigation.
- 29.1 Data contained in a Bid, all documentation provided therein, and innovations developed as a result of the contracted commodities or services cannot be copyrighted or patented. All data, documentation, and innovations become the property of the Sauk County.
- 29.2 Any material submitted by the vendor in response to this request that the vendor considers confidential and proprietary information, and which qualifies as a trade secret, as provided in s. 19.36(5), Wis. Stats., or material which can be kept confidential under the Wisconsin public records law, must be identified. Bid prices cannot be held confidential.
- 30.0 DISCLOSURE:** If a public official (s. 19.42, Wis. Stats.), a member of the public official's immediate family, or any organization in which a public official or a member of the official's immediate family owns or controls a ten percent (10%) interest, is a party to this agreement, and if this agreement involves payment of more than three thousand dollars (\$3,000.00) within a twelve (12) month period, this contract is voidable by the County unless appropriate disclosure is made according to s. 19.45(6), Wis. Stats., before signing the contract.
- 31.0 RECYCLED MATERIALS:** Sauk County desires to purchase products incorporating recycled materials whenever technically and economically feasible. Vendors/bidders are encouraged to Bid/propose products with recycled content, which meet specifications.
- 32.0 PATENT INFRINGEMENT:** The vendor selling to Sauk County the articles described herein guarantees the articles were manufactured or produced in accordance with applicable federal labor laws. Further, that the sale or use of the articles described herein will not infringe any United States patent. The vendor covenants that it will at its own expense defend every suit which shall be brought against Sauk County (provided that such vendor is promptly notified of such suit, and all papers therein are delivered to it) for any alleged infringement of any patent by reason of the sale or use of such articles, and agrees that it will pay all costs, damages, and profits recoverable in any such suit.
- 33.0 SAFETY DATA SHEET:** If any item(s) on an order(s) resulting from this award(s) is a hazardous chemical, as defined under 29CFR 1910.1200, provide one (1) copy of Safety Data Sheet for each item with the shipped container(s) and one (1) copy with the invoice(s).
- 34.0 SUBMISSION OF SAFETY POLICIES/MANUALS.** The vendor will be required to submit a copy of the company's safety policies and manuals to the Sauk County Buildings Services Department for review.
- 35.0 SUBSTANCE ABUSE PROGRAM.** The contractor is required to fully comply with Wis. Stat. § 103.503. This includes, but is not limited to:
- 35.1 The Contractor shall have in place a written program for the prevention of substance abuse among its employees and such written program shall be provided to Sauk County with the contract documents and before any work may be started on the project. The contents of this program shall conform to Wis. Stat. § 103.503.
- 35.2 The Contractor shall be responsible for the cost of developing, implementing, and enforcing this program as laid out in Wis. Stat. § 103.503 (3) (b).
- 36.0 PERFORMANCE BOND/PAYMENT BOND**

- 36.1 The selected Bidder shall furnish Bonds covering the faithful performance of the Contract and payment of all obligations to subcontractors and others who provide materials or labor. ("Bonds"). Bonds may be secured through the Bidder's usual source. Cost of Bonds shall be included in the Bid.
- 36.2 Both Bonds shall be written in the amount of the Contract Sum. The Bidder shall deliver the required Bonds to the Owner with the executed Contract.
- 36.3 A Surety licensed to do business in Wisconsin shall issue the Bonds. Bonds shall be dated on or after the date of the Contract.
- 36.4 If using a Power of Attorney, the Bidder 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. It shall state the monetary limit of the power. In addition, a certified and effective dated copy of the power of attorney shall be affixed to each Bid or Bonds by the Attorney-in-Fact executing documents.

37.0 BID BOND. Bids shall be accompanied by a security deposit as follows:

- 37.1 A Bid bond in the amount equal to 5% of the proposer's bid. Use AIA A310 Bid Bond Form.
- 37.2 Endorse the Bid Bond in the name of the Owner as obligee, signed and sealed by the principal (Contractor) and surety.
- 37.3 The security deposit will be returned after delivery to the Owner of the required Performance and Payment Bond(s) by the accepted bidder.
- 37.4 Include the cost of bid security in the Bid Amount.
- 37.5 After a bid has been accepted, all securities will be returned to the respective bidders and other requested enclosures.
- 37.6 If no contract is awarded, all security deposits will be returned.

38.0 LIST OF SUBCONTRACTORS: Bidder agrees, to the extent practicable, to maintain a list of all subcontractors, suppliers, and service providers performing, furnishing, or procuring labor, services, materials, plans, or specifications under the contract.

39.0 FEES FOR CHANGES IN THE WORK: Include the following with the bid form:

- 39.1 The overhead and profit fees on own Work and Work by subcontractors, applicable for Changes in the Work, whether additions to or deductions from the Work on which the Bid Amount is based.
- 39.2 The fees proposed for subcontract work for changes (both additions and deductions) in the Work. Contractor shall apply fees as noted, to the subcontractors' gross (net plus fee) costs on additional work.

40.0 CONTRACTOR ACKNOWLEDGMENT OF STANDARD TERMS & CONDITIONS:

CONTRACTOR

AUTHORIZED SIGNATURE OF CONTRACTOR

DATE

PART FOUR
EVALUATION INFORMATION

1.0 EVALUATION PROCESS

- 1.1 Completeness of Bid. All requested information is included as noted.
- 1.2 In the event that only one proposal is received in response to this Request for Bid, Sauk County reserves the right to negotiate the terms and conditions, including the price, as proposed in the sole vendor's Bid. In addition, as part of such negotiations, Sauk County reserves the right to require supporting cost, pricing and other data from the vendor in order to determine the reasonableness and acceptability of the Bid.
- 1.3 Sauk County reserves the right to reject any and all bids.

PART FIVE
PRICING & INFORMATION

PRICING	PRICE
Base Bid – Phase 1	\$
Base Bid Phase 2	\$
Base Bid #3	\$
Alternate 1: HVAC Work in Phase 3	\$
Alternate 2: Cost to Provide Bonding	\$

The vendor hereby agrees to provide the services and/or items at the prices quoted, pursuant to the requirements of this document and further agree that when this document is countersigned by an authorized official of Sauk County, a binding contract, as defined herein, shall exist between the vendor and Sauk County.

VENDOR

AUTHORIZED SIGNATURE

Date

PRINTED NAME

Title

Sauk County Official

Date

CONTRACT

See 00 50 00 – Contracting Forms and Supplements for Contract information.

SECTION 00 50 00 - CONTRACTING FORMS AND SUPPLEMENTS

PART 1 GENERAL

1.01 AGREEMENT AND CONDITIONS OF THE CONTRACT

- A. The Agreement is based on AIA A101.
- B. The General Conditions are based on AIA A201.

1.02 FORMS

- A. Use the following forms for the specified purposes unless otherwise indicated elsewhere in Contract Documents.
- B. Post-Award Certificates and Other Forms:
 - 1. Application for Payment Forms: AIA G702 with AIA G703 (for Contractors).
- C. Clarification and Modification Forms:
 - 1. Substitution Request Form: CSI/CSC Form 1.5C (During the Bidding/Negotiating Stage).
 - 2. Substitution Request Form: CSI/CSC Form 13.1A (After the Bidding/Negotiating Stage).
 - 3. Architect's Supplemental Instructions Form: AIA G710.
 - 4. Construction Change Directive Form: AIA G714.
 - 5. Change Order Form: AIA G701.
- D. Closeout Forms:
 - 1. Certificate of Substantial Completion Form: AIA G704.

1.03 REFERENCE STANDARDS

- A. AIA A101 - Standard Form of Agreement Between Owner and Contractor where the basis of Payment is a Stipulated Sum.
- B. AIA A201 - General Conditions of the Contract for Construction.
- C. AIA G701 - Change Order.
- D. AIA G702 - Application and Certificate for Payment.
- E. AIA G703 - Continuation Sheet.
- F. AIA G704 - Certificate of Substantial Completion.
- G. AIA G710 - Architect's Supplemental Instructions.
- H. AIA G714 - Construction Change Directive.
- I. CSI/CSC Form 1.5C - Substitution Request (During the Bidding/Negotiating Stage).
- J. CSI/CSC Form 13.1A - Substitution Request (After the Bidding/Negotiating Phase).

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 00 73 00 - SUPPLEMENTARY CONDITIONS

PART 1 GENERAL

1.01 SUMMARY

- A. These Supplementary Conditions amend and supplement the General Conditions referenced in Document 00 50 00 - Contracting Forms and Supplements and other provisions of Contract Documents as indicated below. Provisions that are not so amended or supplemented remain in full force and effect.
- B. The terms used in these Supplementary Conditions that are defined in the General Conditions have the meanings assigned to them in the General Conditions.

1.02 RELATED REQUIREMENTS

- A. Section 00 50 00 - Contracting Forms and Supplements.
- B. Section 01 42 16 - Definitions.

1.03 MODIFICATIONS TO GENERAL CONDITIONS

- A. A copy of the Supplementary Conditions is appended to the end of this Document.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 10 00 - SUMMARY

PART 1 GENERAL

1.01 PROJECT

- A. Project Name: Sauk County Courthouse HVAC and Lighting Upgrades
- B. Owner's Name: Sauk County.
- C. Architect's Name: Strang, Inc.
- D. Additional Project contact information is specified in Section 00 01 03 - Project Directory.

1.02 DESCRIPTION OF ALTERATIONS WORK

- A. Scope of alterations work is indicated on drawings.

1.03 OWNER OCCUPANCY

- A. Owner intends to occupy the Project upon Substantial Completion.
- B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- C. Schedule the Work to accommodate Owner occupancy.

1.04 CONTRACTOR USE OF SITE

- A. Construction Operations: Limited to areas noted on Drawings.
 - 1. Locate and conduct construction activities in ways that will limit disturbance to site.
- B. Arrange use of site to allow:
 - 1. Owner occupancy.
 - 2. Work by Others.
 - 3. Work by Owner.
- C. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.
- D. Existing building spaces may not be used for storage.
- E. Utility Outages and Shutdown:
 - 1. Limit disruption of utility services to hours the building is unoccupied.
 - 2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 14 days notice to Owner and authorities having jurisdiction.
 - 3. Prevent accidental disruption of utility services to other facilities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 20 00 - PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedures for preparation and submittal of applications for progress payments.
- B. Documentation of changes in Contract Sum and Contract Time.
- C. Change procedures.
- D. Correlation of Contractor submittals based on changes.
- E. Procedures for preparation and submittal of application for final payment.

1.02 RELATED REQUIREMENTS

- A. Section 00 50 00 - Contracting Forms and Supplements: Forms to be used.

1.03 SCHEDULE OF VALUES

- A. Use Schedule of Values Form: AIA G703, or other form acceptable to Owner.
- B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.
- C. Forms filled out by hand will not be accepted.
- D. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.
- E. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification section. Identify site mobilization.
- F. Include in each line item, the amount of Allowances specified in this section. For unit cost Allowances, identify quantities taken from Contract Documents multiplied by the unit cost to achieve the total for the item.
- G. Include separately from each line item, a direct proportional amount of Contractor's overhead and profit.
- H. Revise schedule to list approved Change Orders, with each Application For Payment.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

- A. Payment Period: Submit at intervals stipulated in the Agreement.
- B. Use Form AIA G702 and Form AIA G703, edition stipulated in the Agreement.
- C. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.
- D. Forms filled out by hand will not be accepted.
- E. Execute certification by signature of authorized officer.
- F. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.

- G. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of work.
- H. Include the following with the application:
 - 1. Transmittal letter as specified for submittals in Section 01 30 00.
 - 2. Partial release of liens from major subcontractors and vendors.
 - 3. Affidavits attesting to off-site stored products.
- I. When Architect requires substantiating information, submit data justifying dollar amounts in question.

1.05 MODIFICATION PROCEDURES

- A. Submit name of the individual authorized to receive change documents and who will be responsible for informing others in Contractor's employ or subcontractors of changes to Contract Documents.
- B. For minor changes not involving an adjustment to the Contract Sum or Contract Time, Architect will issue instructions directly to Contractor.
- C. For other required changes, Contractor will issue a document signed by Owner instructing Contractor to proceed with the change, for subsequent inclusion in a Change Order.
 - 1. The document will describe the required changes and will designate method of determining any change in Contract Sum or Contract Time.
 - 2. Promptly execute the change.
- D. For changes for which advance pricing is desired, Architect will issue a document that includes a detailed description of a proposed change with supplementary or revised drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required . Contractor shall prepare and submit a fixed price quotation within 21 days.
- E. Contractor may propose a change by submitting a request for change to Architect, describing the proposed change and its full effect on the work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation.
- F. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.
 - 1. For change requested by Architect for work falling under a fixed price contract, the amount will be based on Contractor's price quotation.
 - 2. For change requested by Contractor, the amount will be based on the Contractor's request for a Change Order as approved by Architect.
 - 3. For pre-determined unit prices and quantities, the amount will based on the fixed unit prices.
- G. Substantiation of Costs: Provide full information required for evaluation.
 - 1. Provide the following data:

- a. Quantities of products, labor, and equipment.
 - b. Include detailed cost breakdown of labor and materials.
 - c. Taxes, insurance, and bonds.
 - d. Overhead and profit.
 - e. Justification for any change in Contract Time.
 - f. Credit for deletions from Contract, similarly documented.
2. Support each claim for additional costs with additional information:
 - a. Origin and date of claim.
 - b. Dates and times work was performed, and by whom.
 - c. Time records and wage rates paid.
 - d. Invoices and receipts for products, equipment, and subcontracts, similarly documented.
3. For Time and Material work, submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.
- H. Execution of Change Orders: Architect or Contractor will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.
- I. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.
- J. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
- K. Promptly enter changes in Project Record Documents.

1.06 APPLICATION FOR FINAL PAYMENT

- A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- B. Application for Final Payment will not be considered until the following have been accomplished:
 1. All closeout procedures specified in Section 01 70 00.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 23 00 - ALTERNATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Description of Alternates.

1.02 RELATED REQUIREMENTS

- A. Document 00 43 23 - Alternates Form: List of Alternates as supplement to Bid Form.

1.03 ACCEPTANCE OF ALTERNATES

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option.
Accepted Alternates will be identified in the Owner-Contractor Agreement.
- B. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

1.04 SCHEDULE OF ALTERNATES

- A. Alternate No. 1 - Provide all work indicated on Drawings for Alternate No. 1. Work includes, but is not limited to demolition work on third floor, demolition and new HVAC systems indicated within the mechanical penthouse.
- B. Alternate No. 2 - Provide Builders Risk Insurance policy as defined in the Supplementary Conditions and General Conditions.. Base Bid is for no Builder's Risk insurance.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures, coordination.
- B. Section 01 60 00 - Product Requirements: Fundamental product requirements, product options, delivery, storage, and handling.

1.03 DEFINITIONS

- A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
 - 1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control.
 - a. Unavailability.
 - b. Regulatory changes.
 - 2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.
 - a. Substitution requests offering advantages solely to the Contractor will not be considered.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
 - 2. Agrees to provide the same warranty for the substitution as for the specified product.
 - 3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
 - 4. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
 - 5. Waives claims for additional costs or time extension that may subsequently become apparent.

6. Agrees to reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.
- B. A Substitution Request for specified installer constitutes a representation that the submitter:
 1. Has acted in good faith to obtain services of specified installer, but was unable to come to commercial, or other terms.
- C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
 1. Note explicitly any non-compliant characteristics.
- D. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
 1. Forms included in the Project Manual are adequate for this purpose, and must be used.
- E. Limit each request to a single proposed substitution item.
 1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 SUBSTITUTION PROCEDURES DURING PROCUREMENT

- A. Submittal Time Restrictions:
 1. Instructions to Bidders specifies time restrictions and the documents required for submitting substitution requests during the bidding period.
- B. Submittal Form (before award of contract):
 1. Submit substitution requests by completing the form attached to this section. See this form for additional information and instructions. Use only this form; other forms of submission are unacceptable.

3.03 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

- A. Submittal Form (after award of contract):
 1. Submit substitution requests by completing the form attached to this section. See this section for additional information and instructions. Use only this form; other forms of submission are unacceptable.
- B. Submit request for Substitution for Cause immediately upon discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
- C. Submit request for Substitution for Convenience within 14 days of discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
 1. In addition to meeting general documentation requirements, document how the requested substitution benefits the Owner through cost savings, time savings, greater energy conservation, or in other specific ways.

2. Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.
3. Bear the costs engendered by proposed substitution of:
 - a. Owner's compensation to the Architect for any required redesign, time spent processing and evaluating the request.
 - b. Other construction by Owner.
 - c. Other unanticipated project considerations.
- D. Substitutions will not be considered under one or more of the following circumstances:
 1. When they are indicated or implied on shop drawing or product data submittals, without having received prior approval.
 2. Without a separate written request.

3.04 RESOLUTION

- A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.
- B. Architect will notify Contractor in writing of decision to accept or reject request.
 1. Architect's decision following review of proposed substitution will be noted on the submitted form.

3.05 ACCEPTANCE

- A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

3.06 ATTACHMENTS

- A. The Substitution Request Forms required to be used on the Project are included after this section.

END OF SECTION

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Substitution Request Form (During Construction)

IDENTIFICATION:

Owner: _____

Contractor: _____

Design Professional: _____

Project Name: _____

Project Number: _____

Substitution Reason: ☐ For Cause ☐ For Convenience Date: _____

REFERENCE:

Substitution Request Title: _____

Substitution Request No.: _____

Specification Title: _____

Specification No.: _____ Page: _____ Article/ Paragraph: _____

DESCRIPTION:

Manufacturer's Name: _____ Model No: _____

Trade Name: _____ Installer: _____

Proposed Substitution General Description: _____

EXPLANATION:

Reason for not providing specified item: _____

Differences between proposed substitution and specified item: _____

Proposed substitution affects other parts of work as follows: _____

Savings to Owner for accepting substitution: _____

Change to Contract Time due to accepting substitution: _____

CERTIFICATION:

The Undersigned certifies:

- Proposed substitution has been investigated and determined that it meets or exceeds the quality level of the specified product.
 - Same warranty will be furnished for proposed substitution as for specified product.
 - Same maintenance service and source of replacement parts, as applicable, is available.
 - Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
 - Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
 - Proposed substitution does not affect dimensions and functional clearances.
 - Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
 - Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.
-

Submitted and Signed by: _____
Name Title

Firm: _____

Address: _____

Telephone: _____

ATTACHED SUPPORTING DATA:

☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

A/E's REVIEW AND ACTION:

- ☐ Substitution approved - Make submittals in accordance with Specification Section 01 2500.
- ☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01 2500.
- ☐ Substitution rejected - Use specified materials.
- ☐ Substitution Request received too late - Use specified materials.

Signed by: _____ Date: _____
Name Title

ADDITIONAL COMMENTS:

☐ Owner ☐ Design Professional ☐ Contractor ☐ Installer ☐ Manufacturer ☐ _____

Substitution Request Form (During Procurement)

IDENTIFICATION:

Owner: _____
Design Professional: _____
Project Name: _____
Project Number: _____ Date: _____

REFERENCE:

Specification Title: _____
Specification No.: _____ Page: _____ Article/ Paragraph: _____

DESCRIPTION:

Manufacturer's Name: _____ Model No: _____
Trade Name: _____
Proposed Substitution General Description: _____

CERTIFICATION:

The Undersigned certifies:

- Proposed substitution has been investigated and determined that it meets or exceeds the quality level of the specified product.
 - Same warranty will be furnished for proposed substitution as for specified product.
 - Same maintenance service and source of replacement parts, as applicable, is available.
 - Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
 - Proposed substitution does not affect dimensions and functional clearances.
 - Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
-

Submitted and Signed by: _____
Name Title

Firm: _____

Address: _____

Telephone: _____

ATTACHED SUPPORTING DATA:

☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

A/E's REVIEW AND ACTION:

- ☐ Substitution approved - Make submittals in accordance with Specification Section 01 2500.
- ☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01 2500.
- ☐ Substitution rejected - Use specified materials.
- ☐ Substitution Request received too late - Use specified materials.

Signed by: _____
Name Title Date

SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General administrative requirements.
- B. Electronic document submittal service.
- C. Preconstruction meeting.
- D. Progress meetings.
- E. Construction progress schedule.
- F. Progress photographs.
- G. Coordination drawings.
- H. Submittals for review, information, and project closeout.
- I. Number of copies of submittals.
- J. Requests for Information (RFI) procedures.
- K. Submittal procedures.

1.02 RELATED REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: General product requirements.
- B. Section 01 70 00 - Execution and Closeout Requirements: Additional coordination requirements.
- C. Section 01 78 00 - Closeout Submittals: Project record documents; operation and maintenance data; warranties and bonds.

1.03 GENERAL ADMINISTRATIVE REQUIREMENTS

- A. Comply with requirements of Section 01 70 00 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.
- B. Make the following types of submittals to Architect:
 - 1. Requests for Information (RFI).
 - 2. Requests for substitution.
 - 3. Shop drawings, product data, and samples.
 - 4. Test and inspection reports.
 - 5. Design data.
 - 6. Manufacturer's instructions and field reports.
 - 7. Applications for payment and change order requests.
 - 8. Progress schedules.
 - 9. Coordination drawings.
 - 10. Correction Punch List and Final Correction Punch List for Substantial Completion.
 - 11. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRONIC DOCUMENT SUBMITTAL SERVICE

- A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF, MS Word, or MS Excel) format, as appropriate to the document, and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email.
 - 1. Besides submittals for review, information, and closeout, this procedure applies to Requests for Information (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
 - 2. Contractor and Architect are required to use this service.
 - 3. It is Contractor's responsibility to submit documents in allowable format.
 - 4. Subcontractors, suppliers, and Architect's consultants will be permitted to use the service at no extra charge.
 - 5. Users of the service need an email address, internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.
 - 6. Paper document transmittals will not be reviewed; emailed electronic documents will not be reviewed.
 - 7. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.

3.02 PRECONSTRUCTION MEETING

- A. Schedule meeting after Notice of Award.
- B. Attendance Required:
 - 1. Owner.
 - 2. Architect.
 - 3. Contractor.
- C. Agenda:
 - 1. Execution of Owner-Contractor Agreement.
 - 2. Submission of executed bonds and insurance certificates.
 - 3. Distribution of Contract Documents.
 - 4. Submission of schedule of values, and progress schedule.

5. Submission of initial Submittal schedule.
 6. Designation of personnel representing the parties to Contract and Architect.
 7. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 8. Scheduling.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.03 PROGRESS MEETINGS

- A. Architect will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- B. Attendance Required:
1. Contractor.
 2. Owner.
 3. Architect.
 4. Contractor's superintendent.
- C. Agenda:
1. Review minutes of previous meetings.
 2. Review of work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems that impede, or will impede, planned progress.
 5. Review of submittals schedule and status of submittals.
 6. Review of RFIs log and status of responses.
 7. Maintenance of progress schedule.
 8. Corrective measures to regain projected schedules.
 9. Planned progress during succeeding work period.
 10. Coordination of projected progress.
 11. Maintenance of quality and work standards.
 12. Effect of proposed changes on progress schedule and coordination.
 13. Other business relating to work.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 CONSTRUCTION PROGRESS SCHEDULE

- A. Within 10 days after date established in Notice to Proceed, submit preliminary schedule.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.

1. Include written certification that major contractors have reviewed and accepted proposed schedule.
- D. Within 10 days after joint review, submit complete schedule.
- E. Submit updated schedule every 30 days.

3.05 PROGRESS PHOTOGRAPHS

- A. Maintain one set of all photographs at project site for reference; same copies as submitted, identified as such.
- B. Photography Type: Digital; electronic files.

3.06 COORDINATION DRAWINGS

- A. Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

3.07 REQUESTS FOR INFORMATION (RFI)

- A. Definition: A request seeking one of the following:
 1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
 2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.
- C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
 1. Prepare a separate RFI for each specific item.
 - a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
 - b. Do not forward requests which solely require internal coordination between subcontractors.
 2. Prepare in a format and with content acceptable to Owner.
 3. Prepare using software provided by the Electronic Document Submittal Service.
 4. Combine RFI and its attachments into a single electronic file. PDF format is preferred.
- D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.

1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
2. Unacceptable Uses for RFIs: Do not use RFIs to request the following:
 - a. Approval of submittals (use procedures specified elsewhere in this section).
 - b. Approval of substitutions (see Section - 01 60 00 - Product Requirements)
 - c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
 - d. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.
 - a. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect, and any of its consultants, due to processing of such RFIs.
- E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
 1. Official Project name and number, and any additional required identifiers established in Contract Documents.
 2. Owner's, Architect's, and Contractor's names.
 3. Discrete and consecutive RFI number, and descriptive subject/title.
 4. Issue date, and requested reply date.
 5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
 6. Annotations: Field dimensions and/or description of conditions which have engendered the request.
 7. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.
- F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

- G. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
 - 1. Indicate current status of every RFI. Update log promptly and on a regular basis.
 - 2. Note dates of when each request is made, and when a response is received.
 - 3. Highlight items requiring priority or expedited response.
 - 4. Highlight items for which a timely response has not been received to date.
- H. Review Time: Architect will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
 - 1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.
- I. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
 - 1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
 - 2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
 - 3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
 - 4. Notify Architect within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.08 SUBMITTAL SCHEDULE

- A. Submit to Architect for review a schedule for submittals in tabular format.
 - 1. Coordinate with Contractor's construction schedule.
 - 2. Format schedule to allow tracking of status of submittals throughout duration of construction.
 - 3. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
 - 4. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.

- a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.

3.09 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
 - 1. Product data.
 - 2. Shop drawings.
 - 3. Samples for selection.
 - 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
- C. Samples will be reviewed for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 - Closeout Submittals.

3.10 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
 - 1. Design data.
 - 2. Certificates.
 - 3. Test reports.
 - 4. Inspection reports.
 - 5. Manufacturer's instructions.
 - 6. Manufacturer's field reports.
 - 7. Other types indicated.
- B. Submit for Architect's knowledge as contract administrator or for Owner.

3.11 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Submit Correction Punch List for Substantial Completion.
- B. Submit Final Correction Punch List for Substantial Completion.
- C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 78 00 - Closeout Submittals:
 - 1. Project record documents.
 - 2. Operation and maintenance data.
 - 3. Warranties.
 - 4. Bonds.
 - 5. Other types as indicated.
- D. Submit for Owner's benefit during and after project completion.

3.12 NUMBER OF COPIES OF SUBMITTALS

- A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
- B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
 - 1. After review, produce duplicates.
 - 2. Retained samples will not be returned to Contractor unless specifically so stated.

3.13 SUBMITTAL PROCEDURES

- A. General Requirements:
 - 1. Use a single transmittal for related items.
 - 2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
 - 3. Transmit using approved form.
 - a. Use Contractor's form, subject to prior approval by Architect.
 - b. Use form generated by Electronic Document Submittal Service software.
 - 4. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
 - 5. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
 - 6. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
 - a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
 - 7. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
 - a. Send submittals in electronic format via email to Architect.
 - b. Upload submittals in electronic form to Electronic Document Submittal Service website.
 - 8. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
 - b. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.

- c. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Architect's approval, allow an additional 30 days.
 9. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
 10. Provide space for Contractor and Architect review stamps.
 11. When revised for resubmission, identify all changes made since previous submission.
 12. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
 13. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
 14. Submittals not requested will be recognized, and will be returned "Not Reviewed",
- B. Product Data Procedures:
1. Submit only information required by individual specification sections.
 - a. Mark each copy to show which choices and options are applicable to project. If the product data is not marked to show applicable choices and options, the Architect reserves the right to return the submittal as: "incomplete" or "without action."
 2. Collect required information into a single submittal.
 3. Do not submit (Material) Safety Data Sheets for materials or products.
- C. Shop Drawing Procedures:
1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
 2. Do not reproduce Contract Documents to create shop drawings.
 3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.
- D. Samples Procedures:
1. Transmit related items together as single package.
 2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.
 3. Include with transmittal high-resolution image files of samples to facilitate electronic review and approval. Provide separate submittal page for each item image.

3.14 SUBMITTAL REVIEW

- A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.
- B. Submittals for Information: Architect will acknowledge receipt, but will take no other action.
- C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.

1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.
- D. Architect's and consultants' actions on items submitted for review:
 1. Authorizing purchasing, fabrication, delivery, and installation:
 - a. "Approved", or language with same legal meaning.
 - b. "Approved as Noted, Resubmission not required", or language with same legal meaning.
 - 1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
 - c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.
 - 1) Resubmit corrected item, with review notations acknowledged and incorporated. Resubmit separately, or as part of project record documents.
 - 2) Non-responsive resubmittals may be rejected.
 2. Not Authorizing fabrication, delivery, and installation:
 - a. "Revise and Resubmit".
 - 1) Resubmit revised item, with review notations acknowledged and incorporated.
 - 2) Non-responsive resubmittals may be rejected.
 - b. "Not Approved".
 - 1) Submit item complying with requirements of Contract Documents.
- E. Architect's and consultants' actions on items submitted for information:
 1. Items for which no action was taken:
 - a. "For Record Only" - to notify the Contractor that the submittal has been received for record only.
 2. Items for which action was taken:
 - a. "Reviewed" - no further action is required from Contractor.

END OF SECTION

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submittals.
- B. Quality assurance.
- C. References and standards.
- D. Testing and inspection agencies and services.
- E. Contractor's construction-related professional design services.
- F. Contractor's design-related professional design services.
- G. Control of installation.
- H. Mock-ups.
- I. Tolerances.
- J. Manufacturers' field services.
- K. Defect Assessment.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures.
- B. Section 01 42 16 - Definitions.
- C. Section 01 60 00 - Product Requirements: Requirements for material and product quality.

1.03 DEFINITIONS

- A. Contractor's Quality Control Plan: Contractor's management plan for executing the Contract for Construction.
- B. Contractor's Professional Design Services: Design of some aspect or portion of the project by party other than the design professional of record. Provide these services as part of the Contract for Construction.
 - 1. Design Services Types Required:
 - a. Construction-Related: Services Contractor needs to provide in order to carry out the Contractor's sole responsibilities for construction means, methods, techniques, sequences, and procedures.
 - b. Design-Related: Design services explicitly required to be performed by another design professional due to highly-technical and/or specialized nature of a portion of the project. Services primarily involve engineering analysis, calculations, and design, and are not intended to alter the aesthetic aspects of the design.
- C. Design Data: Design-related, signed and sealed drawings, calculations, specifications, certifications, shop drawings and other submittals provided by Contractor, and prepared directly by, or under direct supervision of, appropriately licensed design professional.

1.04 CONTRACTOR'S CONSTRUCTION-RELATED PROFESSIONAL DESIGN SERVICES

- A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.
- B. Provide such engineering design services as may be necessary to plan and safely conduct certain construction operations, pertaining to, but not limited to the following:
 - 1. Temporary sheeting, shoring, or supports.
 - 2. Temporary scaffolding.
 - 3. Temporary bracing.
 - 4. Temporary stairs or steps required for construction access only.
 - 5. Temporary hoist(s) and rigging.
 - 6. Investigation of soil conditions and design of temporary foundations to support construction equipment.

1.05 CONTRACTOR'S DESIGN-RELATED PROFESSIONAL DESIGN SERVICES

- A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.
- B. Base design on performance and/or design criteria indicated in individual specification sections.
 - 1. Submit a Request for Information to Architect if the criteria indicated are not sufficient to perform required design services.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.
 - 1. Include calculations that have been used to demonstrate compliance to performance and regulatory criteria provided, and to determine design solutions.
 - 2. Include required product data and shop drawings.
 - 3. Include signature and seal of design professional responsible for allocated design services on calculations and drawings.
- C. Test Reports: After each test/inspection, promptly submit two copies of report to Architect and to Contractor.
 - 1. Test report submittals are for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.
- D. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.

1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- E. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- F. Manufacturer's Field Reports: Submit reports for Architect's benefit as contract administrator or for Owner.
 1. Submit report within 30 days of observation to Architect for information.
 2. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.
- G. Erection Drawings: Submit drawings for Architect's benefit as contract administrator or for Owner.
 1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.

1.07 QUALITY ASSURANCE

- A. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of Contractor by Contract Documents, provide services of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- B. Contractor's Quality Control (CQC) Plan:
 1. Prior to start of work, submit a comprehensive plan describing how contract deliverables will be produced. Tailor CQC plan to specific requirements of the project. Include the following information:
 - a. Management Structure: Identify personnel responsible for quality. Include a chart showing lines of authority.
 - 1) Include qualifications (in resume form), duties, responsibilities of each person assigned to CQC function.
 - b. Management Approach: Define, describe, and include in the plan specific methodologies used in executing the work.
 - 1) Management and control of documents and records relating to quality.
 - 2) Communications.
 - 3) Coordination procedures.
 - 4) Resource management.
 - 5) Process control.

- 6) Inspection and testing procedures and scheduling.
 - 7) Control of noncomplying work.
 - 8) Tracking deficiencies from identification, through acceptable corrective action, and verification.
- c. Owner will not make a separate payment for providing and maintaining a Quality Control Plan. Include associated costs in Bid price.
 - d. Acceptance of the plan is required prior to start of construction activities not including mobilization work. Owner's acceptance of the plan will be conditional and predicated on continuing satisfactory adherence to the plan. Owner reserves the right to require Contractor to make changes to the plan and operations, including removal of personnel, as necessary, to obtain specified quality of work results.

1.08 REFERENCES AND STANDARDS

- A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.
- C. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.
- D. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.
- E. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from Contract Documents by mention or inference otherwise in any reference document.

1.09 TESTING AND INSPECTION AGENCIES AND SERVICES

- A. As indicated in individual specification sections, Owner or Contractor shall employ and pay for services of an independent testing agency to perform specified testing.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have work performed by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 MOCK-UPS

- A. Before installing portions of the Work where mock-ups are required, construct mock-ups in location and size indicated for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work. The purpose of mock-up is to demonstrate the proposed range of aesthetic effects and workmanship.
- B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.
- C. Notify Architect fifteen (15) working days in advance of dates and times when mock-ups will be constructed.
- D. Provide supervisory personnel who will oversee mock-up construction. Provide workers that will be employed during the construction at Project.
- E. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.
- F. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- G. Obtain Architect's approval of mock-ups before starting work, fabrication, or construction.
 - 1. Architect will issue written comments within seven (7) working days of initial review and each subsequent follow up review of each mock-up.
 - 2. Make corrections as necessary until Architect's approval is issued.
- H. Architect will use accepted mock-ups as a comparison standard for the remaining Work.
- I. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect.

3.03 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

3.04 TESTING AND INSPECTION

- A. See individual specification sections for testing and inspection required.
- B. Testing Agency Duties:
 - 1. Test samples of mixes submitted by Contractor.
 - 2. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 - 3. Perform specified sampling and testing of products in accordance with specified standards.
 - 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 5. Promptly notify Architect and Contractor of observed irregularities or non-compliance of Work or products.
 - 6. Perform additional tests and inspections required by Architect.
 - 7. Submit reports of all tests/inspections specified.
- C. Limits on Testing/Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the Work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the Work.
- D. Contractor Responsibilities:
 - 1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
 - 2. Cooperate with laboratory personnel, and provide access to the Work.
 - 3. Provide incidental labor and facilities:
 - a. To provide access to Work to be tested/inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
 - c. To facilitate tests/inspections.
 - d. To provide storage and curing of test samples.
 - 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
 - 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

- 6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- E. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.
- F. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.05 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment as applicable, and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.06 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not complying with specified requirements.
- B. If, in the opinion of Owner, it is not practical to remove and replace the work, Owner will direct an appropriate remedy or adjust payment.

END OF SECTION

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SECTION 01 42 16 - DEFINITIONS

PART 1 GENERAL

1.01 SUMMARY

- A. This section supplements the definitions contained in the General Conditions.
- B. Other definitions are included in individual specification sections.

1.02 DEFINITIONS

- A. Furnish: To supply, deliver, unload, and inspect for damage.
- B. Install: To unpack, assemble, erect, apply, place, finish, cure, protect, clean, start up, and make ready for use.
- C. Product: Material, machinery, components, equipment, fixtures, and systems forming the work result. Not materials or equipment used for preparation, fabrication, conveying, or erection and not incorporated into the work result. Products may be new, never before used, or re-used materials or equipment.
- D. Project Manual: The book-sized volume that includes the procurement requirements (if any), the contracting requirements, and the specifications.
- E. Provide: To furnish and install.
- F. Supply: Same as Furnish.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary utilities.
- B. Temporary telecommunications services.
- C. Temporary sanitary facilities.
- D. Temporary Controls: Barriers, enclosures, and fencing.
- E. Vehicular access and parking.
- F. Waste removal facilities and services.
- G. Project identification sign.

1.02 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 TEMPORARY UTILITIES

- A. Owner will provide the following:
- B. Provide and pay for all electrical power and water required for construction purposes.
- C. New permanent facilities may be used.

1.04 TELECOMMUNICATIONS SERVICES

- A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

1.05 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- B. Maintain daily in clean and sanitary condition.

1.06 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
- C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.07 FENCING

- A. Construction: Contractor's option.
- B. Provide 6 foot high fence around construction site; equip with vehicular gates with locks.

1.08 EXTERIOR ENCLOSURES

- A. Provide temporary weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.09 INTERIOR ENCLOSURES

- A. Provide temporary partitions as indicated to separate work areas from Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.
- B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces:
 - 1. Maximum flame spread rating of 75 in accordance with ASTM E84.

1.10 VEHICULAR ACCESS AND PARKING

- A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.
- B. Coordinate access and haul routes with governing authorities and Owner.
- C. Provide and maintain access to fire hydrants, free of obstructions.
- D. Provide means of removing mud from vehicle wheels before entering streets.
- E. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

1.11 WASTE REMOVAL

- A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
- B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- C. Provide containers with lids. Remove trash from site periodically.
- D. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.12 PROJECT IDENTIFICATION

- A. Provide project identification sign of design, construction, and location approved by Owner.
- B. No other signs are allowed without Owner permission except those required by law.

1.13 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Final Application for Payment inspection.
- B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing facilities used during construction to original condition.
- E. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General product requirements.
- B. Transportation, handling, storage and protection.
- C. Manufacturer's warranties and special warranties.
- D. Product option requirements.
- E. Substitution limitations.
- F. Procedures for Owner-supplied products.
- G. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

- A. Section 01 25 00 - Substitution Procedures: Substitutions made during procurement and/or construction phases.

1.03 SUBMITTALS

- A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
 - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by Contract Documents.
- B. Use of products having any of the following characteristics is not permitted:
 - 1. Made outside the United States, its territories, Canada, or Mexico.
 - 2. Made using or containing CFC's or HCFC's.
 - 3. Made of wood from newly cut old growth timber.
 - 4. Containing lead, cadmium, or asbestos.

2.02 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver and place in location as directed; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

- A. See Section 01 25 00 - Substitution Procedures.

3.02 OWNER-SUPPLIED PRODUCTS

- A. Owner's Responsibilities:
 - 1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
 - 2. Arrange and pay for product delivery to site.
 - 3. On delivery, inspect products jointly with Contractor.
 - 4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
 - 5. Arrange for manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
 - 1. Review Owner reviewed shop drawings, product data, and samples.
 - 2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
 - 3. Handle, store, install and finish products.
 - 4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.
- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

- A. Provide protection of stored materials and products against theft, casualty, or deterioration.
- B. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
 - 1. Structural Loading Limitations: Handle and store products and materials so as not to exceed static and dynamic load-bearing capacities of project floor and roof areas.
- C. Store and protect products in accordance with manufacturers' instructions.
- D. Store with seals and labels intact and legible.
- E. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.
- F. For exterior storage of fabricated products, place on sloped supports above ground.
- G. Provide off-site storage and protection when site does not permit on-site storage or protection.
- H. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- I. Comply with manufacturer's warranty conditions, if any.
- J. Do not store products directly on the ground.
- K. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- L. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- M. Prevent contact with material that may cause corrosion, discoloration, or staining.
- N. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- O. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

3.05 PRODUCT WARRANTIES

- A. Include warranties specified in other Sections, in addition to the other warranties required by the Contract Documents. Ensure warranties run concurrently. Manufacturer's disclaimers and limitations on product warranties do not exempt Contractor of fulfilling obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Furnish written warranty from the individual manufacturer for the particular product, specifically endorsed by the manufacturer to the Owner.
 - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for the Owner.
- B. Special Warranties: Prepare a written document containing 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 the indicated form, executed properly.
 - 3. Refer to other Sections for specific content requirements and guidelines for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 70 00 - Execution and Closeout Requirements and Section 01 78 00 - Closeout Submittals.

END OF SECTION

SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Requirements for alterations work, including selective demolition.
- C. Pre-installation meetings.
- D. Cutting and patching.
- E. Surveying for laying out the work.
- F. Cleaning and protection.
- G. Starting of systems and equipment.
- H. Demonstration and instruction of Owner personnel.
- I. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.
- J. General requirements for maintenance service.

1.02 RELATED REQUIREMENTS

- A. Section 01 50 00 - Temporary Facilities and Controls: Temporary exterior enclosures.
- B. Section 01 50 00 - Temporary Facilities and Controls: Temporary interior partitions.
- C. Section 01 79 00 - Demonstration and Training: Demonstration of products and systems to be commissioned and where indicated in specific specification sections

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of Project.
 - 2. Integrity of weather exposed or moisture resistant element.
 - 3. Efficiency, maintenance, or safety of any operational element.
 - 4. Visual qualities of sight exposed elements.
 - 5. Work of Owner or separate Contractor.
 - 6. Include in request:
 - a. Identification of Project.
 - b. Location and description of affected work.
 - c. Necessity for cutting or alteration.
 - d. Description of proposed work and products to be used.
 - e. Effect on work of Owner or separate Contractor.
 - f. Written permission of affected separate Contractor.
 - g. Date and time work will be executed.

- C. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.04 QUALIFICATIONS

- A. For surveying work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate. Employ only individual(s) trained and experienced in collecting and recording accurate data relevant to ongoing construction activities,
- B. For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.05 PROJECT CONDITIONS

- A. Use of explosives is not permitted.
- B. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- C. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
- D. Perform dewatering activities, as required, for the duration of the project.
- E. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- F. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
1. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Owner.
- G. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
- H. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.
- I. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.
- J. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.06 COORDINATION

- A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

- B. Notify affected utility companies and comply with their requirements.
- C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of work of separate sections.
- G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

- A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify Architect Seven days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of examination, preparation and installation procedures.
 - 2. Review coordination with related work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 LAYING OUT THE WORK

- A. Verify locations of survey control points prior to starting work.
- B. Promptly notify Architect of any discrepancies discovered.
- C. Contractor shall locate and protect survey control and reference points.
- D. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- E. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
- F. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.
- G. Utilize recognized engineering survey practices.
- H. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
 - 1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
 - 2. Grid or axis for structures.
 - 3. Building foundation, column locations, ground floor elevations.

- I. Periodically verify layouts by same means.
- J. Maintain a complete and accurate log of control and survey work as it progresses.

3.05 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of alterations work constitutes acceptance of existing conditions.
- B. Keep areas in which alterations are being conducted separated from other areas that are still occupied.
 - 1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 .
- C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
 - 1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.
 - 2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.
- D. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove items indicated on drawings.
 - 2. Relocate items indicated on drawings.
 - 3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
 - 4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.

- E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
 - 2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
 - 3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
 - b. Provide temporary connections as required to maintain existing systems in service.
 - 4. Verify that abandoned services serve only abandoned facilities.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.
- F. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
- G. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
 - 1. When existing finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect.
 - 2. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
 - 3. Where a change of plane of 1/4 inch or more occurs in existing work, submit recommendation for providing a smooth transition for Architect review and request instructions.
- H. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
- I. Refinish existing surfaces as indicated:

1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
 2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
- J. Clean existing systems and equipment.
- K. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- L. Do not begin new construction in alterations areas before demolition is complete.
- M. Comply with all other applicable requirements of this section.

3.07 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. See Alterations article above for additional requirements.
- C. Perform whatever cutting and patching is necessary to:
1. Complete the work.
 2. Fit products together to integrate with other work.
 3. Provide openings for penetration of mechanical, electrical, and other services.
 4. Match work that has been cut to adjacent work.
 5. Repair areas adjacent to cuts to required condition.
 6. Repair new work damaged by subsequent work.
 7. Remove samples of installed work for testing when requested.
 8. Remove and replace defective and non-complying work.
- D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- E. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- G. Restore work with new products in accordance with requirements of Contract Documents.
- H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.
- J. Patching:

1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
2. Match color, texture, and appearance.
3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.08 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.09 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.10 SYSTEM STARTUP

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect and Owner seven days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.

- F. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
- G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.11 DEMONSTRATION AND INSTRUCTION

- A. See Section 01 79 00 - Demonstration and Training.

3.12 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.13 FINAL CLEANING

- A. Execute final cleaning after Substantial Completion but before making final application for payment.
- B. Use cleaning materials that are nonhazardous.
- C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- D. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- F. Clean filters of operating equipment.
- G. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, and drainage systems.
- H. Clean site; sweep paved areas, rake clean landscaped surfaces.
- I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.14 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
- B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.
- C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.

- D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.
- E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
- F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.
- H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.15 MAINTENANCE

- A. Provide service and maintenance of components indicated in specification sections.
- B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.
- C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION

SECTION 01 71 23 - FIELD ENGINEERING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Field engineering services by Contractor.
- B. Land surveying services by Contractor.
- C. Construction surveying by Contractor.
- D. Support and bracing.

1.02 DESCRIPTION OF SERVICES

- A. Specific services listed in this section are in addition to, and do not supersede, general Execution and Closeout Requirements.
- B. Sole responsibility for establishing all locations, dimensions and levels of items of work.
- C. Sole responsibility for provision of all materials required to establish and maintain benchmarks and control points, including batter boards, grade stakes, structure elevation stakes, and other items.
- D. Keeping a transit, theodolite, or TST (total station theodolite with electronic distance measurement device); leveling instrument; and related implements such as survey rods and other measurement devices, at the project site at all times.
- E. Provision of facilities and assistance necessary for Architect to check lines and grade points placed by Contractor.
 - 1. Performance of excavation or embankment work until after all cross-sectioning necessary for determining payment quantities for Unit Price work have been completed and accepted by Architect.
- F. Preparation and maintenance of daily reports of activity on the work. Submission of reports containing key progress indicators and job conditions to Architect.
 - 1. Major equipment and materials installed as part of the work.
 - 2. Location of areas in which construction was performed.
 - 3. Work performed, including field quality control measures and testing.
 - 4. Weather conditions.
 - 5. Instructions received from Architect or Owner, if any.
- G. Preparation and maintenance of professional-quality, accurate, well organized, legible notes of all measurements and calculations made while surveying and laying out the work.

1.03 REFERENCE STANDARDS

- A. FGDC-STD-007.1 - Geospatial Positioning Accuracy Standards - Part 1: Reporting Methodology.

- B. FGDC-STD-007.2 - Geospatial Positioning Accuracy Standards - Part 2: Standards for Geodetic Networks.
- C. FGDC-STD-007.4 - Geospatial Positioning Accuracy Standards - Part 4: Architecture, Engineering, Construction, and Facilities Measurement.
- D. State Plane Coordinate System for the State in which the Project is located.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify layout information shown on drawings in relation to property survey and existing benchmarks.
- B. Notify Owner's representative and Architect of discrepancies immediately in writing before proceeding to lay out work.
- C. Locate and protect existing benchmarks, base lines, and demarcations. Preserve permanent reference points during construction.
- D. Existing Utilities and Equipment: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify existing conditions.

3.02 FIELD ENGINEERING

- A. Maintain field office files, drawings, specifications, and record documents.
- B. Coordinate field engineering services with Contractor's subcontractors, installers, and suppliers as appropriate.
- C. Prepare layout and coordination drawings for construction operations.
- D. Check and coordinate the work for conflicts and interferences, and immediately advise Architect and Owner of all discrepancies of which Contractor is aware.
- E. Cooperate as required with Architect and Owner in observing the work and performing field inspections.
- F. Review and coordinate work on a regular basis with shop drawings and Contractor's other submittals.
- G. In general, match existing adjacent grades and maintain existing flow lines.
- H. Check the location, line and grade of every major element as the work progresses. Notify the Architect when deviations from required lines or grades exceed allowable tolerances. Include in such notifications a thorough explanation of the problem, and a proposed plan and schedule for remedying the deviation. Do not proceed with remedial work without Owner's concurrence of the remediation plan.

3.03 LAND SURVEYING

- A. General: Follow standards for geospatial positioning accuracy.
 - 1. FGDC-STD-007.1 as amended by Authority Having Jurisdiction.
 - 2. FGDC-STD-007.2 as amended by Authority Having Jurisdiction.
 - 3. FGDC-STD-007.4 as amended by Authority Having Jurisdiction.
- B. Coordinate survey data with the State Plane Coordinate System of the State in which the Project is located.
- C. Contractor is responsible for the restoration of all property corners and control monuments damaged or destroyed by construction-related activities. Any disturbed monuments must be replaced at Contractor's expense by a surveyor licensed in the State in which the Project is located, and approved by the Architect.
 - 1. Temporarily suspend work at such points and for such reasonable times as the Owner may require for resetting monuments. The Contractor will not be entitled to any additional compensation or extension of time.

3.04 CONSTRUCTION SURVEYING

- A. General: Perform surveying as applicable to specific items necessary for proper execution of work.
 - 1. Alignment Staking: Provide alignment stakes at 50 foot intervals on tangent, and at 25 foot intervals on curves.
 - 2. Slope Staking: Provide slope staking at 50 foot intervals on tangent, and at 25 foot intervals on curves. Re-stake at every ten-foot difference in elevation.
 - 3. Structure: Stake out structures, including elevations, and check prior to and during construction.
- B. Record Log: Maintain a log of layout control work. Record any deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used.
- C. Accuracy:
 - 1. Establish Contractor's temporary survey references points for Contractor's use to at least second-order accuracy (e.g., 1:10000). Set construction staking used as a guide for the work to at least third-order accuracy (e.g., 1:5000). Provide the absolute margin for error specified below on the basis established by such orders.
 - a. Accuracy of Other Staking: Plus/minus 0.04 foot horizontally and plus/minus 0.02 foot vertically.
 - b. Include an error analysis sufficient to demonstrate required accuracy in survey calculations.

2. Owner reserves the right to check the Contractor's survey, measurements, and calculations. The requirement for accuracy will not be waived, whether this right is exercised or not.

3.05 SUPPORT AND BRACING

- A. General requirements: Design all support and bracing systems, if required. Provide for attachment to portions of the building structure capable of bearing the loads imposed. Design systems to not overstress the building structure.

3.06 RECORDS

- A. Maintain at the Site a complete and accurate log of control and survey work as it progresses.
 1. Organize and record survey data in accordance with recognized professional surveying standards, Laws and Regulations, and prevailing standards of practice in the State in which the Project is located. Record Contractor's surveyor's original field notes, computations, and other surveying data in Contractor-furnished hard-bound field books. Contractor is solely responsible for completeness and accuracy of survey work, and completeness and accuracy of survey records, including field books. Survey records,(including field books) may be rejected by Owner due to failure to organize and maintain survey records in a manner that allows reasonable and independent verification of calculations, and/or allows identification of elevations, dimensions, and grades of the work.
 2. Illegible notes or data, and erasures on any page of field books, are unacceptable. Do not submit copied notes or data. Corrections by ruling or lining out errors will be unacceptable unless initialed by the surveyor. Violation of these requirements may require re-surveying the data questioned by Architect.
- B. Submit three copies of final property survey to Owner. Include on the survey a certification, signed by the surveyor, that principal metes, bounds, lines, and levels of the Project are accurately positioned as shown on the survey. Include the following information:
 1. Structure locations from property lines, and distances to adjacent buildings.
 2. Dimensions and locations of drives, walks, walls, underground utilities, appurtenances, and major site features.
 3. Location of easements.

END OF SECTION

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

- A. Owner requires that this project generate the least amount of trash and waste possible.
- B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.
- C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
- D. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
 - 1. Aluminum and plastic beverage containers.
 - 2. Corrugated cardboard.
 - 3. Wood pallets.
 - 4. Clean dimensional wood.
 - 5. Concrete: May be crushed and used as riprap, aggregate, sub-base material, or fill.
 - 6. Asphalt paving: May be recycled into paving for project.
 - 7. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
 - 8. Gypsum drywall and plaster.
 - 9. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed: DuPont (<http://flooring.dupont.com>) and Interface (www.interfaceinc.com) conduct reclamation programs.
- E. Methods of trash/waste disposal that are not acceptable are:
 - 1. Burning on the project site.
 - 2. Burying on the project site.
 - 3. Dumping or burying on other property, public or private.
 - 4. Other illegal dumping or burying.
- F. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 RELATED REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.

1.03 DEFINITIONS

- A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
- B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.
- C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.
- D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.
- E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
- F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
- H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- I. Return: To give back reusable items or unused products to vendors for credit.
- J. Reuse: To reuse a construction waste material in some manner on the project site.
- K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
- L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
- M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- N. Toxic: Poisonous to humans either immediately or after a long period of exposure.
- O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
- P. Waste: Extra material or material that has reached the end of its useful life in its intended use.
Waste includes salvageable, returnable, recyclable, and reusable material.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 WASTE MANAGEMENT PROCEDURES

- A. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

- B. See Section 01 50 00 for additional requirements related to trash/waste collection and removal facilities and services.
- C. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.
- D. See Section 01 70 00 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

3.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

- A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.
- B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.
- C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.
- D. Meetings: Discuss trash/waste management goals and issues at project meetings.
 - 1. Prebid meeting.
 - 2. Preconstruction meeting.
 - 3. Regular job-site meetings.
- E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
 - 1. As a minimum, provide:
 - a. Separate area for storage of materials to be reused on-site, such as wood cut-offs for blocking.
 - b. Separate dumpsters for each category of recyclable.
 - c. Recycling bins at worker lunch area.
 - 2. Provide containers as required.
 - 3. Provide adequate space for pick-up and delivery and convenience to subcontractors.
 - 4. If an enclosed area is not provided, clearly lay out and label a specific area on-site.
 - 5. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.
- F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.
- G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

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- H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.
- I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION

SECTION 01 78 00 - CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project record documents.
- B. Operation and maintenance data.
- C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Section 01 70 00 - Execution and Closeout Requirements: Contract closeout procedures.
- C. Individual Product Sections: Specific requirements for operation and maintenance data.
- D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect prior to claim for final Application for Payment.
 - 1. Format: Digital copy in PDF format.
- B. Operation and Maintenance Data:
 - 1. Submit copy of preliminary draft or proposed formats and outlines of contents before start of Work. Architect will review draft and return one copy with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 3. Submit copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned, with Architect comments. Revise content of all document sets as required prior to final submission.
 - 4. Submit one set of revised final documents in final form within 10 days after final inspection.
 - 5. Format: Digital copy in PDF format.
- C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

4. Format: Digital copy in PDF format.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 1. Drawings.
 2. Specifications.
 3. Addenda.
 4. Change Orders and other modifications to the Contract.
 5. Reviewed shop drawings, product data, and samples.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 1. Product substitutions or alternates utilized.
 2. Changes made by Addenda and modifications.
- F. Record Drawings: Legibly mark each item to record actual construction including:
 1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 3. Field changes of dimension and detail.
 4. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. For Each Product, Applied Material, and Finish:
 - 1. Product data, with catalog number, size, composition, and color and texture designations.
- B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
- C. Additional information as specified in individual product specification sections.
- D. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.
- C. Include color coded wiring diagrams as installed.
- D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- E. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- F. Include manufacturer's printed operation and maintenance instructions.
- G. Include sequence of operation by controls manufacturer.
- H. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- I. Provide control diagrams by controls manufacturer as installed.
- J. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.
- K. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- L. Include test and balancing reports.
- M. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than one specification section, provide separate tabbed divider for each system.
- C. Cover: Identify each digital binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- D. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.
- E. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
- F. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
- G. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
- H. Arrangement of Contents: Organize each volume in parts as follows:
 - 1. Project Directory.
 - 2. Table of Contents, of all volumes, and of this volume.
 - 3. Operation and Maintenance Data: Arranged by system, then by product category.
 - a. Source data.
 - b. Product data, shop drawings, and other submittals.
 - c. Operation and maintenance data.
 - d. Field quality control data.
 - e. Photocopies of warranties and bonds.

3.06 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Retain warranties and bonds until time specified for submittal.
- E. Cover: Identify each digital binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.

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- F. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.
- G. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

END OF SECTION

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

- A. Demonstration of products and systems where indicated in specific specification sections.
- B. Training of Owner personnel in operation and maintenance is required for:
 - 1. HVAC systems and equipment.
 - 2. Electrical systems and equipment.
 - 3. Items specified in individual product Sections.

1.02 RELATED REQUIREMENTS

- A. Section 01 78 00 - Closeout Submittals: Operation and maintenance manuals.
- B. Other Specification Sections: Additional requirements for demonstration and training.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.
- B. Demonstration may be combined with Owner personnel training if applicable.
- C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.
 - 2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

- A. Conduct training on-site unless otherwise indicated.
- B. Provide training in minimum two hour segments.
- C. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
- D. Review of Facility Policy on Operation and Maintenance Data: During training discuss:

1. The location of the O&M manuals and procedures for use and preservation; backup copies.
 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
 3. Typical uses of the O&M manuals.
- E. Product- and System-Specific Training:
1. Review the applicable O&M manuals.
 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
 4. Provide hands-on training on all operational modes possible and preventive maintenance.
 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 6. Discuss common troubleshooting problems and solutions.
 7. Discuss any peculiarities of equipment installation or operation.
 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 10. Review spare parts and tools required to be furnished by Contractor.
 11. Review spare parts suppliers and sources and procurement procedures.
- F. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION

SECTION 02 41 00 - DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of building elements for alteration purposes.

1.02 DEFINITIONS

- A. Remove: Detach or dismantle items from existing construction and dispose of them off site, unless items are indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label and deliver salvaged items to Owner in ready-for-reuse condition.
- C. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall where indicated.
- D. Existing to Remain: Designation for existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.03 REFERENCE STANDARDS

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.04 FIELD CONDITIONS

- A. Hazardous Materials: Hazardous materials are assumed to be present in buildings and structures to be selectively demolished.
 - 1. Lead:
 - a. No lead testing is required. Lead is present in existing layers of paint, wood stain on and around existing wood windows. Assume all coated surfaces contain lead. Perform work in accordance with EPA regulations and OSHA "Lead in Construction Standard 29 CFR1926.62".
 - 2. Asbestos:
 - a. Past testing has shown that the various materials are asbestos containing material (ACM).
 - b. Work of this contract includes testing of existing foundation coatings (waterproofing/dampproofing) at demolition location in compliance with EPA and OSHA regulations.
 - 3. Notify Owner of test results. If friable PACM is detected, Owner will contract for abatement. For non-friable materials, remove materials to sufficiently install new foundation walls and associated waterproofing and louver.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.
 - 1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 - 2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 4. Provide, erect, and maintain temporary barriers and security devices.
 - 5. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 6. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 7. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
 - 8. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.

9. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Protect existing structures and other elements to remain in place and not removed.
 1. Provide bracing and shoring.
 2. Prevent movement or settlement of adjacent structures.
 3. Stop work immediately if adjacent structures appear to be in danger.
- D. Hazardous Materials:
 1. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury.
- E. Perform demolition in a manner that maximizes salvage and recycling of materials.
 1. Dismantle existing construction and separate materials.
 2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.
- F. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.03 EXISTING UTILITIES

- A. Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
- H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone. Identify and mark, in same manner as other utilities to remain, utilities to be reconnected.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
 1. Verify construction and utility arrangements are as indicated.

2. Report discrepancies to Architect before disturbing existing installation.
3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Separate areas in which demolition is being conducted from areas that remain occupied.
 1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 .
- C. Maintain weatherproof exterior building enclosure, except for interruptions required for replacement or modifications; prevent water and humidity damage.
- D. Remove existing work as indicated and required to accomplish new work.
 1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction indicated.
 2. Remove items indicated on drawings.
- E. Services (Including but not limited to HVAC, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 1. Maintain existing active systems to remain in operation, and maintain access to equipment and operational components.
 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 3. Verify that abandoned services serve only abandoned facilities before removal.
 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings. Remove back to source of supply where possible, otherwise cap stub and tag with identification.
- F. Hole Coring for Utilities:
 1. Use ground-penetrating radar to review reinforcing locations in walls or slabs and position holes so as to avoid cutting of concrete reinforcing if at all possible, or otherwise arrange core locations to cut the minimum necessary. Verify all core sizes with the appropriate trades. 6 inch maximum core holes.
- G. Protect existing work to remain.
 1. Prevent movement of structure. Provide shoring and bracing as required.
 2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
 4. Patch to match new work.

3.05 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.

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C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

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SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof-mounted curbs.
- B. Roofing nailers.
- C. Preservative treated wood materials.
- D. Fire retardant treated wood materials.
- E. Communications and electrical room mounting boards.
- F. Concealed wood blocking, nailers, and supports.

1.02 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
- C. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
- D. ASTM D3498 - Standard Specification for Adhesives for Field-Gluing Wood Structural Panels (Plywood or Oriented Strand Board) to Wood Based Floor System Framing.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- F. AWPA U1 - Use Category System: User Specification for Treated Wood.
- G. PS 1 - Structural Plywood.
- H. PS 20 - American Softwood Lumber Standard.
- I. SPIB (GR) - Standard Grading Rules.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials and sheathing.

1.04 QUALITY ASSURANCE

- A. Roofing Wood Nailers: Wood Nailers shall be secured in accordance with FM Global Property Loss Prevention Data Sheet 1-49.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Southern Pine Inspection Bureau, Inc; SPIB (GR).
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS

- A. Wall Sheathing: Plywood, PS 1, Grade C-D, Exposure I.
- B. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.04 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
- B. Sill Gasket on Top of Foundation Wall: 1/4 inch thick, plate width, closed cell plastic foam from continuous rolls.
- C. General Purpose Construction Adhesives: Comply with ASTM C557.

2.05 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.

2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPAs standards.
- B. Fire Retardant Treatment:
1. Exterior Type: AWPAs U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat exterior rough carpentry items.
 - c. Do not use treated wood in direct contact with the ground.
 2. Interior Type A: AWPAs U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Interior rough carpentry items are to be fire retardant treated.
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
1. Preservative Pressure Treatment of Lumber Above Grade: AWPAs U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber in contact with flashing or waterproofing.
 - c. Treat lumber in contact with masonry or concrete.
 2. Preservative Pressure Treatment of Plywood Above Grade: AWPAs U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 - b. Treat plywood in contact with flashing or waterproofing.
 - c. Treat plywood in contact with masonry or concrete.

PART 3 EXECUTION

3.01 PREPARATION

- A. Install sill gasket under sill plate of framed walls bearing on foundations; puncture gasket cleanly to fit tightly around protruding anchor bolts.

3.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to authorities having jurisdiction may be used in lieu of solid wood blocking.
- C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- D. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.

3.04 ROOF-RELATED CARPENTRY

- A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.
- B. Provide wood curb at each roof opening except where specifically indicated otherwise; form corners by alternating lapping side members.

3.05 INSTALLATION OF CONSTRUCTION PANELS

- A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws.
- B. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.

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1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
3. Install adjacent boards without gaps.

3.06 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

END OF SECTION

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SECTION 07 05 53 - FIRE AND SMOKE ASSEMBLY IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Identification markings for fire and smoke rated partitions, and fire rated walls.

1.02 REFERENCE STANDARDS

- A. ICC (IBC) - International Building Code.

1.03 FIELD CONDITIONS

- A. Do not install adhered markings when ambient temperature is lower than recommended by label or sign manufacturer.
- B. Do not install markings when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 SYSTEM SELECTION

- A. At Contractor's option, select signs or painted system.

2.02 MANUFACTURERS

- A. Partition Identification Labels:
 - 1. Fire Wall Signs, Inc: www.firewallsigns.com/#sle.
 - 2. Safety Supply Warehouse, Inc: www.safetysupplywarehouse.com/#sle.
 - 3. Or approved equal.

2.03 FIRE AND SMOKE ASSEMBLY IDENTIFICATION

- A. Regulatory Requirements: Comply with "Marking and Identification" requirements of "Fire-Resistance Ratings and Fire Tests" chapter of ICC (IBC).
- B. Adhered Fire and Smoke Assembly Identification Signs: Printed vinyl sign with factory applied adhesive backing.
- C. Applied Fire and Smoke Assembly Identification: Identification markings applied to partition with spray paint and a code compliant stencil. Provide acrylic paint as manufactured by Krylon, Rustoleum, or approved equal.
- D. Languages: Provide sign markings in English.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION

- A. Locate markings as required by ICC (IBC).

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- B. Install adhered markings in accordance with manufacturer's instructions.
- C. Install neatly, with horizontal edges level.
- D. Protect from damage until Date of Substantial Completion; repair or replace damaged markings.

END OF SECTION

SECTION 07 13 00 - SHEET WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Self-adhered modified bituminous sheet membrane.

1.02 REFERENCE STANDARDS

- A. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension.
- B. ASTM D882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
- C. ASTM D5295/D5295M - Standard Guide for Preparation of Concrete Surfaces for Adhered (Bonded) Membrane Waterproofing Systems.
- D. ASTM D5385/D5385M - Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes.
- E. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- F. NRCA (WM) - The NRCA Waterproofing Manual.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for membrane, surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants.
- C. Manufacturer's Installation Instructions: Indicate special procedures.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Contractor to correct defective Work within period of five years after Date of Substantial Completion; remove and replace materials concealing waterproofing at no extra cost to Owner.

- C. Provide five year manufacturer warranty for waterproofing failing to resist penetration of water, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.

PART 2 PRODUCTS

2.01 SHEET WATERPROOFING APPLICATIONS

- A. Self-Adhered Modified Bituminous Sheet Membrane:
 - 1. Location: Joints between new and existing concrete walls.
 - 2. Cover with drainage panel.

2.02 SHEET WATERPROOFING MATERIALS

- A. Self-Adhered Modified Bituminous Sheet Membrane:
 - 1. Thickness: 60 mil, 0.060 inch, minimum.
 - 2. Tensile Strength:
 - a. Film: 5,000 psi, minimum, measured in accordance with ASTM D882 and at grip-separation rate of 2 inches per minute.
 - b. Membrane: 325 psi, minimum, measured in accordance with ASTM D412 Method A, using die C and at spindle-separation rate of 2 inches per minute.
 - 3. Elongation at Break: 300 percent, minimum, measured in accordance with ASTM D412.
 - 4. Water Vapor Permeance: 0.05 perm, maximum, measured in accordance with ASTM E96/E96M.
 - 5. Hydrostatic Pressure Resistance: Membrane resists leakage for at least one hour from pressure equivalent to 200 feet head of water applied in accordance with test method ASTM D5385/D5385M.
 - 6. Adhesives, Sealants, Tapes, and Accessories: As recommended by membrane manufacturer.
 - 7. Manufacturers:
 - a. Carlisle Coatings & Waterproofing Inc: www.carlisleccw.com/#sle.
 - b. CETCO, a division of Minerals Technologies Inc: www.mineralstech.com/#sle.
 - c. GCP Applied Technologies: www.gcpat.com/#sle.
 - d. Henry Company: www.henry.com/#sle.
 - e. Tremco Commercial Sealants & Waterproofing.
 - f. W.R. Meadows, Inc: www.wrmeadows.com/#sle.

2.03 ACCESSORIES

- A. Priming and Seaming Materials: As recommended by membrane manufacturer.
- B. Membrane Sealant: As recommended by membrane manufacturer.
- C. Sealant for Cracks and Joints In Substrates: Resilient elastomeric joint sealant compatible with substrates and waterproofing materials.

- D. Drainage Panel: Drainage layer with geotextile filter fabric on earth side.
 - 1. Composition: Dimpled polystyrene, polyethylene, or polypropylene core; polypropylene filter fabric.
 - 2. Thickness: 3/8 inch.
- E. Flexible Flashings: Type recommended by membrane manufacturer.
- F. Termination Bars: Aluminum; compatible with membrane and adhesives.
- G. Adhesives: As recommended by membrane manufacturer.
- H. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions are acceptable prior to starting work.
- B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.
- C. Verify that items penetrating surfaces to receive waterproofing are securely installed.

3.02 PREPARATION

- A. Protect adjacent surfaces from damage not designated to receive waterproofing.
- B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions.
- C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.
- D. Fill nonmoving joints and cracks with a filler compatible with waterproofing materials.
- E. Seal moving cracks with sealant and nonrigid filler, using procedures recommended by sealant and waterproofing manufacturers.
- F. Surfaces for Adhesive Bonding: Apply surface conditioner at a rate recommended by manufacturer, and protect conditioner from rain or frost until dry.
- G. Concrete Surfaces for Adhesive Bonding: Prepare concrete substrate in accordance with ASTM D5295/D5295M.
 - 1. Remove substances that inhibit adhesion including form release agents, curing compounds admixtures, laitance, moisture, dust, dirt, grease and oil.
 - 2. Repair surface defects including honeycombs, fins, tie holes, bug holes, sharp offsets, rutted cracks, ragged corners, deviations in surface plane, spalling and delaminations, as described in reference standard.
 - 3. Remove and replace areas of defective concrete; see Section 03 30 00.
 - 4. Prepare concrete for adhesive bonded waterproofing using mechanical or chemical methods described in referenced standard.

5. Test concrete surfaces as described in referenced standards, and verify surfaces are ready to receive adhesive bonded waterproofing membrane system.

3.03 INSTALLATION - MEMBRANE

- A. Install membrane waterproofing in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.
- B. Roll out membrane, and minimize wrinkles and bubbles.
- C. Self-Adhering Membrane: Remove release paper layer, and roll out onto substrate with a mechanical roller to provide full contact bond.
- D. Overlap edges and ends, minimum 3 inches, seal permanently waterproof by method recommended by manufacturer, and apply uniform bead of sealant to joint edge.
- E. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic.
- F. Weather lap joints on sloped substrate in direction of drainage, and seal joints and seams.
- G. Flexible Flashings: Seal items watertight that penetrate through waterproofing membrane with flexible flashings.
- H. Seal membrane and flashings to adjoining surfaces.
 1. Install termination bar along top edges.

3.04 INSTALLATION - DRAINAGE PANEL

- A. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward; scribe and cut boards around projections, penetrations, and interruptions.
- B. Place protection board directly against drainage panel; butt joints, and scribe and cut boards around projections, penetrations, and interruptions.
- C. Adhere drainage panel to substrate with compatible adhesive.

3.05 PROTECTION

- A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION

SECTION 07 53 23 - ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING (EPDM) - ELEVATE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. EPDM membrane roofing system modifications.

1.02 REFERENCE STANDARDS

- A. ASTM D4637/D4637M - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
- B. ASTM D4811/D4811M - Standard Specification for Nonvulcanized (Uncured) Rubber Sheet Used as Roof Flashing.
- C. FM 4470 - Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction.
- D. NRCA (RM) - The NRCA Roofing Manual.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide membrane manufacturer's printed data showing roofing system components comply with specified requirements and with membrane manufacturer's requirements and recommendations for system type specified; include data for each product used in conjunction with roofing membrane, including insulation and fasteners.
 - 2. Provide documentation showing roofing system is UL classified or FM approved where UL or FM requirements are specified; include data itemizing classified or approved system components.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- D. Manufacturer's Instructions: Indicate installation of components; where instructions allow installation options, clearly indicate which option to use.
- E. Installer's qualification statement.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of this section with minimum five years of documented experience installing specified system and having the following:
 - 1. Qualifications to uphold existing Firestone Red Shield EPDM 15 year, 55 mph warranty.
 - a. Warranty No. 700371325
 - b. Project No. 3418513
 - c. Contractor: Long Life, Inc. 40000762.

- B. Documents at Project Site: Maintain at project site one copy of manufacturer's installation instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.
- B. Store materials clear of ground and moisture with weather-protective covering.
- C. Keep combustible materials away from ignition sources.

1.06 FIELD CONDITIONS

- A. Do not apply roofing membrane during unsuitable weather or when ambient conditions conflict with manufacturer's installation instructions.
- B. Schedule applications so no partially completed sections of roof are left exposed at end of workday.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Membrane Roofing System:
 - 1. Elevate (Formerly Firestone Building Products Company, LLC.) :
www.holcimelevate.com/#sle.
- B. Insulation: Same manufacturer as roof membrane.
- C. Metal Roof Edging: Same manufacturer as roof membrane.
- D. Substitutions: Not permitted.
- E. Source Limitations: Furnish products produced by single manufacturer.

2.02 EPDM MEMBRANE ROOFING SYSTEM

- A. Description: EPDM single-ply membrane.
 - 1. Provide assembly having Underwriters Laboratories, Inc. (UL) Class B fire hazard classification.
- B. Components, from Top of Roof Down:
 - 1. Membrane: Thickness as specified below.

2.03 MEMBRANE MATERIALS

- A. Roofing and Flashing Membrane: Cured synthetic single-ply membrane composed of EPDM with the following properties:
 - 1. Reinforcement: Polyester weft-inserted scrim; membrane complying with ASTM D4637/D4637M, Type II.
 - 2. Membrane and Flashing Color: Black.
 - 3. Thickness: 60 mils, 0.06 inch
 - 4. Nominal Thickness Tolerance: Plus/minus 10 percent.

5. Products: Match existing.
- B. Flashing Membrane: Self-curing, nonreinforced membrane composed of nonvulcanized EPDM rubber, complying with ASTM D4811/D4811M, Type II, with the following properties:
 1. Thickness: 55 mils, 0.055 inch.
 2. Product: Elevate; RubberGard EPDM FormFlash.
- C. Self-Adhesive Flashing Membrane: Semi-cured 45-mil, 0.045-inch EPDM membrane laminated to 35-mil, 0.035-inch EPDM tape adhesive.
 1. Product: Elevate; QuickSeam Flashing.
- D. Self-Adhesive Lap Splice Tape: 35 mil EPDM based, formulated for compatibility with EPDM membrane and high-solids primer.
 1. Product: Elevate; QuickSeam Splice Tape.
- E. Splice Adhesive: Manufacturer's recommended synthetic polymer-based, formulated for compatibility with EPDM membrane and metal surfaces.
- F. Bonding Adhesive: Manufacturer's recommended bonding adhesive, formulated for compatibility with EPDM membrane and other substrate materials, including masonry, wood, and insulation facings.
- G. Lap Sealant: Manufacturer's recommended lap sealant formulated for compatibility with primers and flashings.
- H. AP Sealant: Manufacturer's recommended single-component, polyurethane, nonsag, moisture-curing sealant.
- I. Seam Edge Treatment: Manufacturer's recommended EPDM rubber-based sealant, formulated for sealing exposed membrane edges at seams.
- J. Pourable Sealer: Manufacturer's recommended two-part polyurethane, two-color for reliable mixing.
- K. Water Block Seal: Manufacturer's recommended butyl rubber sealant for use between two surfaces, not exposed.
- L. Metal Plates and Strips Used for Fastening Membrane and Insulation: Steel with galvalume coating; comply with FM 4470 criteria for corrosion resistance.
- M. Termination Bars: Aluminum bars with integral caulk ledge; 1.3 inches wide by 0.1 inch thick.
 1. Product: Elevate; Termination Bar.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine roof deck to determine deck is sufficiently rigid to support installers and mechanical equipment so deflection will not strain or rupture roof components or deform deck.
- B. Verify surfaces and site conditions are ready to receive work. Correct defects in substrate before commencing with roofing work.

- C. Examine roof substrate to verify adequate slope to drains.
- D. Verify specifications and drawing details are workable and not in conflict with roofing manufacturer's recommendations and instructions; start of work constitutes acceptable project conditions and requirements.

3.02 INSTALLATION - GENERAL

- A. Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for specified roofing system. Where manufacturer provides no instructions or recommendations, follow NRCA (RM) written requirements and industry standards. Comply with federal, state, and local regulations.
- B. Obtain relevant instructions and maintain copies at project site for duration of installation period.
- C. Provide temporary closures to ensure moisture does not damage completed roofing. Use flashings, terminations, and temporary closures to provide watertight installation.

3.03 INSTALLATION - SINGLE-PLY MEMBRANE

- A. Lay out membrane pieces so field and flashing splices are installed to shed water.
- B. Install membrane without wrinkles and without gaps or fishmouths in seams; bond and test seams and laps in accordance with membrane manufacturer's instructions and details.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspection by Manufacturer: Provide final inspection of roofing system by technical representative employed by roofing system manufacturer to inspect installation for warranty purposes, not a sales person.
- C. Perform corrections necessary for issuance of warranty.

3.05 CLEANING

- A. Clean contaminants generated by roofing work from building and surrounding areas, including bitumen, adhesives, sealants, and coatings.
- B. Remove leftover materials, trash, debris, and equipment from project site and surrounding areas.

3.06 PROTECTION

- A. Where construction traffic continues over finished roof panels, provide durable protection and replace or repair damaged roofing to original condition.

END OF SECTION

SECTION 07 84 00 - FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not.

1.02 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
- C. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- D. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies.
- E. FM (AG) - FM Approval Guide.
- F. ITS (DIR) - Directory of Listed Products.
- G. SCAQMD 1168 - Adhesive and Sealant Applications.
- H. UL (DIR) - Online Certifications Directory.
- I. UL (FRD) - Fire Resistance Directory.
- J. UL 1479 - Standard for Fire Tests of Penetration Firestops.
- K. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems.

1.03 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes or cut openings to accommodate through-penetration firestop systems.
- C. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.
- D. Coordinate gypsum barrier construction prior to installing penetrating items and firestop to ensuring barrier integrity and continuity.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- C. System Drawings: Submit documentation from a qualified third-party testing agency that is applicable to each firestopping system configuration for construction, joint opening width and/or penetrating items.

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
 - 1. Trained by manufacturer.

1.06 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Firestopping Manufacturers:
 - 1. 3M Fire Protection Products: www.3m.com/firestop/#sle.
 - 2. A/D Fire Protection Systems Inc: www.adfire.com/#sle.
 - 3. Hilti, Inc: www.us.hilti.com/#sle.
 - 4. RectorSeal, a CSW Industries Company: www.rectorseal.com/firestop-solutions/#sle.
 - 5. Specified Technologies Inc: www.stifirestop.com/#sle.
 - 6. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.

2.02 MATERIALS

- A. Firestopping Materials: Any materials meeting requirements.
- B. Obtain firestopping systems for each type of penetration or joint opening and construction condition indicated from a single manufacturer.
- C. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.
- D. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
- B. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
 - 2. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.
- C. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
 - 1. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

2.04 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
 - 1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to prevent liquid material from leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

- B. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- C. Install labeling required by code.

3.04 FIELD QUALITY CONTROL

- A. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 07 92 00 - JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Self-leveling pourable joint sealants.
- C. Joint backings and accessories.

1.02 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
- B. ASTM C834 - Standard Specification for Latex Sealants.
- C. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- E. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- F. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants.
- G. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
- H. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness.
- I. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- J. SCAQMD 1168 - Adhesive and Sealant Applications.
- K. UL 263 - Standard for Fire Tests of Building Construction and Materials.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Backing material recommended by sealant manufacturer.
 - 4. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 5. Substrates the product should not be used on.
- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- D. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.

- E. Samples for Verification: Where custom sealant color is specified, obtain directions from Architect and submit at least two physical samples for verification of color of each required sealant.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sealants:
 - 1. Bostik Inc: www.bostik-us.com/#sle.
 - 2. Dow Chemical Company: consumer.dow.com/en-us/industry/ind-building-construction.html/#sle.
 - 3. Hilti, Inc: www.us.hilti.com/#sle.
 - 4. Master Builders Solutions by BASF: www.master-builders-solutions.basf.us/en-us/#sle.
 - 5. Momentive Performance Materials, Inc (formerly GE Silicones): www.momentive.com/#sle.
 - 6. Pecora Corporation: www.pecora.com/#sle.
 - 7. Sika Corporation: www.usa-sika.com/#sle.
 - 8. Specified Technologies Inc: www.stifirestop.com/#sle.
 - 9. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.

2.02 JOINT SEALANT APPLICATIONS

- A. Scope:
 - 1. Exterior Joints:
 - a. Seal the following joints:
 - 1) Joints between doors, windows, and other frames or adjacent construction.
 - 2) Joints between different exposed materials.
 - 2. Interior Joints:
 - a. Seal the following joints:
 - 1) Joints between door frames, window frames, and other frames and adjacent construction.
 - 2) In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, and piping penetrations.

- 3) In sound-rated wall and ceiling assemblies, seal joints between wall assemblies and ceiling assemblies; between wall assemblies and other construction; between ceiling assemblies and other construction.
3. Do Not Seal:
 - a. Intentional weep holes in masonry.
 - b. Joints indicated to be covered with expansion joint cover assemblies.
 - c. Joints where sealant is specified to be furnished and installed by manufacturer of product to be sealed.
 - d. Joints where sealant installation is specified in other sections.
 - B. Exterior Joints: Use non-sag non-staining silicone sealant, unless otherwise indicated.
 - C. Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.
 1. Wall and Ceiling Joints in Non-Wet Areas: Acrylic emulsion latex sealant.
 2. Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.
 3. In Sound-Rated Assemblies: Acrylic emulsion latex sealant.
 4. Narrow Control Joints in Interior Concrete Slabs: Self-leveling polyurethane sealant.
 5. Other Floor Joints: Self-leveling polyurethane traffic-grade sealant.
 - D. Interior Wet Areas: Bathrooms, restrooms, and kitchens; fixtures in wet areas include plumbing fixtures, countertops, cabinets, and other similar items.
 - E. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.03 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.

2.04 NONSAG JOINT SEALANTS

- A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 1. Movement Capability: Plus and minus 50 percent, minimum.
 2. Nonstaining to Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
 3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 4. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
 5. Color: To be selected by Architect from manufacturer's full range.
- B. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
 1. Color: White.

- C. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 35 percent, minimum.
 - 2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 - 3. Color: To be selected by Architect from manufacturer's full range.
- D. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, non-staining, non-bleeding, non-sagging; not intended for exterior use.
 - 1. Color: Standard colors matching finished surfaces, Type OP (opaque).
 - 2. Grade: ASTM C834; Grade 32 Degrees F (0 Degrees C).
- E. Acrylic Latex Sealant: ASTM C834; for use as acoustical sealant and in firestopping systems for expansion joints and through penetrations.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Fire Rated System: Complies with UL 263 and ASTM E119 with UL fire resistance classifications.

2.05 SELF-LEVELING JOINT SEALANTS

- A. Self-Leveling Polyurethane Sealant for Horizontal Expansion Joints: ASTM C920, Grade P, Uses T, M, and O; multicomponent; explicitly approved by manufacturer for horizontal expansion joints.
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Hardness Range: 30 to 35, Shore A, when tested in accordance with ASTM C661.
 - 3. Color: To be selected by Architect from manufacturer's full range.
- B. Rigid Self-Leveling Polyurethane Joint Filler: Two part, low viscosity, fast setting; intended for cracks and control joints not subject to significant movement.
 - 1. Hardness Range: Greater than 100, Shore A, and 50 to 80, Shore D, when tested in accordance with ASTM C661.
- C. Semi-Rigid Self-Leveling Epoxy Joint Filler: Epoxy or epoxy/polyurethane copolymer; intended for filling cracks and control joints not subject to significant movement; rigid enough to support concrete edges under traffic.
 - 1. Composition: Multicomponent, 100 percent solids by weight.
 - 2. Durometer Hardness: Minimum of 85 for Type A or 35 for Type D, after seven days when tested in accordance with ASTM D2240.
 - 3. Color: To be selected by Architect from manufacturer's standard colors.
 - 4. Joint Width, Minimum: 1/8 inch.

2.06 ACCESSORIES

- A. Sealant Backing Materials, General: Materials placed in joint before applying sealants; assists sealant performance and service life by developing optimum sealant profile and preventing three-sided adhesion; type and size recommended by sealant manufacturer for compatibility with sealant, substrate, and application.
- B. Sealant Backing Rod, Closed-Cell Type:
 - 1. Cylindrical flexible sealant backings complying with ASTM C1330 Type C.
 - 2. Size: 25 to 50 percent larger in diameter than joint width.
- C. Sealant Backing Rod, Bi-Cellular Type:
 - 1. Cylindrical flexible sealant backings complying with ASTM C1330 Type B.
 - 2. Size: 25 to 50 percent larger in diameter than joint width.
- D. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- E. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- F. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- G. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.
- E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in an inconspicuous area to verify that it does not stain or discolor slab.

3.03 INSTALLATION

- A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with ASTM C1193.

- C. Install acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve the following:
 - 1. Width/depth ratio of 2:1.
 - 2. Neck dimension no greater than 1/3 of the joint width.
 - 3. Surface bond area on each side not less than 75 percent of joint width.
- E. Install bond breaker backing tape where backer rod cannot be used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.
- I. Concrete Floor Joint Filler: After full cure, shave joint filler flush with top of concrete slab.

END OF SECTION

SECTION 08 91 00 - LOUVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Louvers, frames, and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 23 31 00 - HVAC Ductwork: Ductwork attachment to louvers and blank-off panels.

1.03 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
- B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.
- C. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices.
- D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.
- C. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, and tolerances; head, jamb and sill details; blade configuration, screens, blank-off areas required, and frames.
- D. Samples: Submit two samples 2 by 2 inches in size illustrating finish and color of exterior and interior surfaces.
- E. Test Reports: Independent agency reports showing compliance with specified performance criteria.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer's warranty against distortion, metal degradation, and connection failures of louver components.
 - 1. Finish: Include ten year coverage against degradation of exterior finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Louvers:
 - 1. Airlite Company, LLC: www.airolite.com/#sle.
 - 2. American Warming and Ventilating: www.awv.com/#sle.
 - 3. Construction Specialties, Inc: www.c-sgroup.com/#sle.
 - 4. Greenheck.
 - 5. Industrial Louvers, Inc: www.industriallouvers.com/#sle.
 - 6. Ruskin: www.ruskin.com/#sle.
 - 7. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LOUVERS

- A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified in accordance with AMCA 511.
 - 1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf without damage or permanent deformation.
 - 2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
 - 3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
- B. Stationary Louvers: Horizontal blade, extruded aluminum construction, with intermediate mullions matching frame.
 - 1. Free Area: 50 percent, minimum.
 - 2. Pressure Drop: 0.061 inches of water gauge maximum per square foot of free area at velocity of 1250 fpm, when tested in accordance with AMCA 500-L, test unit size 48 inch by 48 inch.
 - 3. Blades: Drainable.
 - 4. Frame: 6 inches deep, channel profile; corner joints mitered and, with continuous recessed caulking channel each side.
 - 5. Aluminum Thickness: Frame 12 gauge, 0.0808 inch minimum; blades 12 gauge, 0.0808 inch minimum.
 - 6. Aluminum Finish: Class I natural anodized; finish welded units after fabrication.

2.03 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Stainless Steel: ASTM A666/A666M, Type 304, soft temper, smooth surface, No. 4 brushed finish.

2.04 FINISHES

- A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

2.05 ACCESSORIES

- A. Blank-Off Panels: Specified in Section 23 31 00.
- B. Insect Screen: 18 x 16 size aluminum mesh.
- C. Fasteners and Anchors: Stainless steel.
- D. Extended Sill Flashings: Of same material as louver frame, formed to required shape, single length in one piece per location.
- E. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared openings and flashings are ready to receive this work and opening dimensions are as indicated on shop drawings.
- B. Verify that field measurements are as indicated.

3.02 INSTALLATION

- A. Install louver assembly in accordance with manufacturer's instructions.
- B. Install louvers level and plumb.
- C. Set sill members and sill flashing in continuous bead of sealant.
- D. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- E. Secure louver frames in openings with concealed fasteners.
- F. Coordinate with installation of mechanical ductwork.

3.03 CLEANING

- A. Strip protective finish coverings.

END OF SECTION

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SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal stud wall framing.
- B. Metal channel ceiling framing.
- C. Acoustic insulation.
- D. Gypsum wallboard.
- E. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

1.03 REFERENCE STANDARDS

- A. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data.
- B. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing.
- C. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- F. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
- G. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- H. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- I. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- J. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
- K. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
- L. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- M. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
- N. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.

- O. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.
- P. ASTM C1396/C1396M - Standard Specification for Gypsum Board.
- Q. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- R. GA-216 - Application and Finishing of Gypsum Panel Products.
- S. GA-226 - Application of Gypsum Board to Form Curved Surfaces.
- T. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- B. Store metal products to prevent corrosion, under cover and above grade.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 - 1. See PART 3 for finishing requirements.

2.02 METAL FRAMING MATERIALS

- A. Material and Product Requirements Criteria: AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
 - 1. Structural Grade: As required to meet design criteria.
 - 2. Corrosion Protection Coating Designation: G40, or equivalent in accordance with AISI S220.
- C. Non-structural Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
 - 1. Studs: "C" shaped.
 - 2. Runners: U shaped, sized to match studs.
 - 3. Ceiling Channels: C-shaped.
 - 4. Flexible Track: Flexible framing consisting of adjustable leg straps and pivoting, hinged track brackets designed to provide curved framing assemblies of varying radii.

5. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
 6. Furring Members: U-shaped sections, minimum depth of 3/4 inch.
 7. Furring Members: Zee-shaped sections, minimum depth of 1 inch.
 8. Resilient Furring Channels: Single or double leg configuration; 1/2 inch channel depth.
- D. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short.
- E. Non-structural Framing Accessories:
1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
 - a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
 3. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.
- F. Grid Suspension Systems: Steel grid system of main tees and support bars connected to structure using hanging wire.
1. Products:
 - a. CertainTeed Corporation; Quickspan Locking Drywall Grid System: www.certainteed.com/ceilings-and-walls/#sle.
 - b. USG Corporation; Drywall Suspension System: www.usg.com/#sle.
 - c. Armstrong World Industries, Inc.; Drywall Grid System.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 3. National Gypsum Company: www.nationalgypsum.com/#sle.
 4. USG Corporation: www.usg.com/#sle.
- B. GWB - Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold-resistant board is required whenever board is being installed before the building is enclosed and conditioned.
 - b. Mold resistant board is required in toilet and shower rooms.
 3. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 4. Thickness:

- a. Vertical Surfaces: 5/8 inch.
- b. Ceilings: 5/8 inch.
- C. Backing Board For Wet Areas:
 - 1. Application: Substrate behind tile.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
 - a. Fire-Resistance-Rated Type: Type X core, thickness 5/8 inch.
 - b. Products:
 - 1) CertainTeed Corporation; 5/8" GlasRoc Tile Backer Type X: www.certainteed.com/#sle.
 - 2) Georgia-Pacific Gypsum; DensShield Tile Backer: www.gpgypsum.com/#sle.
 - 3) Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Tile Backer: www.goldbondbuilding.com/#sle.
 - 4) USG Corporation; Durock Brand Glass-Mat Tile Backerboard 5/8 in. (15.9 mm): www.usg.com/#sle.
- D. Exterior Sheathing Board: See Section 06 10 00.

2.04 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness 3-1/2 inch.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
 - 1. Products:
 - a. Franklin International, Inc; Titebond Acoustical Smoke & Sound Sealant: www.titebond.com/#sle.
 - b. Specified Technologies Inc; Smoke N Sound Acoustical Sealant: www.stifirestop.com/#sle.
- C. Sound Barrier Mullion Trim Cap (Partition Gap Closure): Extruded aluminum trim for maintaining sound barriers at intersections between gypsum walls and glazing assemblies.
 - 1. STC: 55.
 - 2. Gasket Thickness: 1/2 inch.
 - 3. Finish: Match glazing assembly framing finish.
 - 4. Products:
 - a. Mull-It-Over Products, Inc; Mull-It-Over Series: mullitoverproducts.com/#sle.
 - b. Gordon, Inc.; Mullion Mate Series.
- D. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, unless noted otherwise.

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1. Corner Beads: Standard profile, for 90 degree outside corners.
 - a. Products:
 - 1) CertainTeed Corporation; No-Coat Drywall Corner: www.certainteed.com/#sle.
 - 2) ClarkDietrich; Strait-Flex OS-300: www.clarkdietrich.com/#sle.
 - 3) Trim-Tex, Inc; Corner Bead: www.trim-tex.com/#sle.
 2. L-Trim with Tear-Away Strip: Sized to fit 5/8 inch thick gypsum wallboard.
 3. Expansion Control Joints:
 - a. Fire-Resistance Rated: 1 or 2 hour as indicated when joint system tested in accordance with UL 2079.
 - b. Type: V-shaped PVC with tear away fins.
 - c. Products:
 - 1) Phillips Manufacturing Co; 093 Expansion Control Joint: www.phillipsmfg.com/#sle.
 - 2) Trim-Tex, Inc; Fire Rated 093V Expansion Bead: www.trim-tex.com/#sle.
 - 3) Or approved equal.
- E. Decorative Metal Trim:
1. Material: Extruded aluminum alloy 6063-T5 temper.
 2. Finish: Anodized, clear, unless indicated ot.
 3. Type: Profile as selected from manufacturer's standard range.
- F. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
1. Paper Tape: 2 inch wide, creased paper tape for joints and corners.
 2. Joint Compound: Drying type, vinyl-based, ready-mixed.
- G. Finishing Compound: Surface coat and primer, takes the place of skim coating.
- H. High Build Drywall Surfer: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish.
- I. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- J. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.
- K. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C1007/AISI S220 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
 - 1. Laterally brace entire suspension system.
- C. Studs: Space studs at 16 inches on center.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 - 3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
 - 4. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Standard Wall Furring: Install at concrete and masonry walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
- F. Blocking: Install wood blocking or mechanically fastened steel sheet blocking for support of:
 - 1. Framed openings.
 - 2. Wall-mounted cabinets.
 - 3. Plumbing fixtures.
 - 4. Toilet partitions.
 - 5. Toilet accessories.
 - 6. Wall-mounted door hardware.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

1. Place one bead continuously on substrate before installation of perimeter framing members.
 2. Place continuous bead at perimeter of each layer of gypsum board.
 3. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.
- C. Sound Barrier Mullion Trim Cap Installation: Install in accordance with manufacturer's instructions for installation of fire-rated mullion trim caps.

3.04 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations. Stagger butt end joints.
- B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
- C. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- D. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.
- E. Curved Surfaces: Apply gypsum board to curved substrates in accordance with GA-226.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

- A. Expansion Control Joints: Place expansion control joints consistent with lines of building spaces and as follows:
 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.
- D. Decorative Trim: Install at locations shown on drawings and in accordance with manufacturer's instructions.

3.06 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish, dry erase coatings, and other areas specifically indicated.
 2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 3. Level 3: Walls to receive textured wall finish.
 4. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.

- 5. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 - 2. Taping, filling, and sanding are not required at base layer of double-layer applications.
- D. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.07 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

SECTION 09 51 00 - ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.
- C. Removal and replacement of existing systems.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- D. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Samples: Submit two samples 3 by 4 inch in size illustrating material and finish of acoustical units.
- D. Samples: Submit two samples each, 6 inches long, of suspension system main runner, cross runner, and perimeter molding.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.05 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acoustic Tiles/Panels/Grid:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - a. Plan note #3: New 2 x 2 Certainteed Cashmere 15/16" reveal edge (tegular) tile, white. Grid is 15/16" exposed tee suspended system in white.
 - b. Plan Note #5: New 2 x 2 Certainteed Adagio 15/16" reveal edge (tegular) tile, white. Grid is 15/16" exposed tee suspension system in white.:
 - 2. No product substitutions will be allowed.

2.02 ACOUSTICAL UNITS

- A. Acoustical Panels: As indicated on Drawings:
 - 1. Products: As indicated on Interior Finish Schedule.

2.03 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, clips, and splices as required.
 - 1. Materials:
 - a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
 - b. Aluminum Grid: Aluminum sheet, ASTM B209/B209M.
- B. Exposed Suspension System: Hot-dipped galvanized steel grid and cap.
 - 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 - 2. Finish: Baked enamel.
 - 3. Color: White.
- C. Exposed Suspension System: Aluminum grid and cap.
 - 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 - 2. Finish: Baked enamel.
 - 3. Color: White

2.04 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.
- C. Hold-Down Clips: Manufacturer's standard clips to suit application.
- D. Perimeter Moldings: Same metal and finish as grid.
 - 1. Size: As required for installation conditions.

2. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
 3. Shadow Molding: Shaped to create a perimeter reveal.
 4. Acoustical Sealant For Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.
- E. Metal Edge Trim for Suspension Systems: Steel or extruded aluminum; provide attachment clips, splice plates, and preformed corner pieces for complete trim system.
1. Finish: Baked enamel.
 2. Color: White.
- F. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.
- C. Remove and salvage ceiling components as indicated.

3.03 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Do not hang system from roof deck.
- D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 1. Install in bed of acoustical sealant.
 2. Use longest practical lengths.
 3. Miter corners.
- E. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

- H. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- I. Do not eccentrically load system or induce rotation of runners.

3.04 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E. Cutting Acoustical Units:
 - 1. Cut to fit irregular grid and perimeter edge trim.
 - 2. Make field cut edges of same profile as factory edges.
 - 3. Double cut and field paint exposed reveal edges.
- F. Where round obstructions occur, provide preformed closures to match perimeter molding.
- G. Install hold-down clips on panels within 20 ft of an exterior door.

3.05 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

- A. Clean surfaces.
- B. Replace damaged or abraded components.

END OF SECTION

SECTION 09 90 00 - PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Interior painting and coating systems.
- C. Exterior painting and coating systems.
- D. Scope:
 - 1. Finish surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - a. Exterior:
 - 1) Concrete: Non-vehicular floors, patios, porches, steps, and platforms.
 - 2) Metal: Aluminum, galvanized.
 - 3) Metal, Miscellaneous: Iron, ornamental iron, structural iron and steel, ferrous metal.
 - b. Interior:
 - 1) Concrete, Walls and Ceilings: Poured concrete, precast concrete, unglazed brick, cement board, tilt-up, cast-in-place concrete, and plaster.
 - 2) Masonry CMU: Concrete, split face, scored, smooth, high density, low density, and fluted.
 - 3) Metal: Aluminum and galvanized.
 - 4) Metal, Galvanized: Ceilings and ductwork.
 - 5) Drywall: Walls, ceilings, gypsum board, and similar items.

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency.
- B. SSPC-SP 1 - Solvent Cleaning.
- C. SSPC-SP 2 - Hand Tool Cleaning.
- D. SSPC-SP 6 - Commercial Blast Cleaning.
- E. SSPC-SP 13 - Surface Preparation of Concrete.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:

1. Product characteristics.
 2. Surface preparation instructions and recommendations.
 3. Primer requirements and finish specification.
 4. Storage and handling requirements and recommendations.
 5. Application methods.
 6. Clean-up information.
- C. Samples: Submit four paper draw down samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
- D. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements for additional provisions.
 2. Extra Paint and Finish Materials: 1 gallon of each color; from the same product run, store where directed.
 3. Label each container with color in addition to manufacturer's label.

1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 3 years experience and approved by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, product name, product code, color designation, VOC content, batch date, environmental handling, surface preparation, application, and use instructions.
- C. Paint Materials: Store at a minimum of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.06 FIELD CONDITIONS

- A. Do not apply materials when environmental conditions are outside the ranges required by manufacturer.
- B. Follow manufacturer's recommended procedures for producing the best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design Products: Subject to compliance with requirements, provide Sherwin-Williams Company (The) products indicated; www.sherwin-williams.com/#sle.
- B. Comparable Products: Products of approved manufacturers will be considered in accordance with 01 60 00 - Product Requirements, and the following:
 - 1. Products are approved by manufacturer in writing for application specified.
 - 2. Products that meet or exceed performance and physical characteristics of basis of design products.
 - 3. Other Acceptable Manufacturers:
 - a. Benjamin Moore.
 - b. Diamond Vogel Paints.
 - c. Hallman Lindsay.
 - d. PPG Paints.

2.02 PAINTINGS AND COATINGS

- A. General:
 - 1. Provide factory-mixed coatings unless otherwise indicated.
 - 2. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application.
 - 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless specifically indicated in manufacturer's instructions.
- B. Volatile Organic Compound (VOC) Content:
 - 1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - b. Ozone Transport Commission (OTC) Phase II Model Rule, Architectural and Industrial Maintenance Coatings; www.otcair.org.
 - c. Architectural coatings VOC limits of State in which the project is located.
 - 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site, or other method acceptable to authorities having jurisdiction.
- C. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Concrete: Curb paint. (Traffic Marking Paint)

1. Marking Paint: In accordance with AASHTO MP 24
 - a. Color: Yellow
- B. Metal: Aluminum, galvanized.
 1. Latex Systems:
 - a. Semi-Gloss Finish:
 - 1) 1st and 2nd Coats: Sherwin-Williams Pro Industrial Acrylic Semi-Gloss, B66-650 Series: www.sherwin-williams.com/#sle.
 - a) 2 to 4 mils dry per coat.
- C. Metal, Miscellaneous: Iron, ornamental iron, structural iron and steel, ferrous metal.
 1. Latex Systems:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
 - a) 5 to 10 mils wet, 1.8 to 3.6 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Acrylic Semi-Gloss, B66-650 Series: www.sherwin-williams.com/#sle.
 - a) 2 to 4 mils dry per coat.

2.04 PAINT SYSTEMS - INTERIOR

- A. Concrete, Walls an: Poured concrete, precast concrete, unglazed brick, cement board, tilt-up, cast-in-place concrete, and plaster.
 1. Latex Systems:
 - a. Eg-Shel Finish:
 - 1) 1st Coat: Sherwin-Williams Loxon Concrete and Masonry Primer Sealer, LX02W50 Series: www.sherwin-williams.com/#sle.
 - a) 8 mils wet, 3.2 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Eg-Shel, B20-2600 Series: www.sherwin-williams.com/#sle.
 - a) 4 mils wet, 1.7 mils dry per coat.
- B. Masonry CMU: Concrete, split face, scored, smooth, high density, low density, and fluted.
 1. Latex Systems:
 - a. Eg-Shel/Satin Finish:
 - 1) 1st Coat: Sherwin-Williams PrepRite Block Filler, B25W25: www.sherwin-williams.com/#sle.
 - a) 75 to 125 sq ft/gal.

- 2) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Eg-Shel, B20-2600 Series: www.sherwin-williams.com/#sle.
 - a) 4 mils wet, 1.7 mils dry per coat.
- C. Metal: Aluminum and galvanized.
 1. Alkyd Systems, Water Based:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
 - a) 5 mils wet, 2 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Water Based Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series: www.sherwin-williams.com/#sle.
 - a) 4 to 5 mils wet, 1.4 to 1.7 mils dry per coat.
- D. Metal, Galvanized: Ceilings and ductwork.
 1. Dryfall Waterborne Topcoats:
 - a. Flat Finish:
 - 1) 1st and 2nd Coat: Sherwin-Williams Pro Industrial Waterborne Acrylic Dryfall, B42-181 Series: www.sherwin-williams.com/#sle.
 - a) 6 mils wet, 1.7 mils dry per coat.
- E. Drywall: Walls, ceilings, gypsum board, and similar items.
 1. Latex Systems:
 - a. Eg-Shel Finish: Walls.
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - a) 4 mils wet, 1.5 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Eg-Shel, B20-2600 Series: www.sherwin-williams.com/#sle.
 - a) 4 mils wet, 1.7 mils dry per coat.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- C. Test shop-applied primer for compatibility with subsequent cover materials.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove mildew from impervious surfaces by scrubbing with solution of water and bleach.
Rinse with clean water and allow surface to dry.
- D. Concrete:
 - 1. Remove release agents, curing compounds, efflorescence, and chalk.
 - 2. Fill bug holes, air pockets, and other voids with cement patching compound.
 - 3. Prepare concrete according to SSPC-SP 13.
- E. Masonry: Remove efflorescence and chalk.
- F. Gypsum Board: Fill minor defects with filler compound; sand smooth and remove dust prior to painting.
- G. Aluminum: Remove surface contamination and oil; wash with solvent according to SSPC-SP 1.
- H. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 - 2. Prepare surface according to SSPC-SP 2.
- I. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Prime bare steel surfaces.
 - 3. Remove rust, loose mill scale, and other foreign substances using methods recommended by paint manufacturer and blast cleaning according to SSPC-SP 6. Protect from corrosion until coated.

3.03 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions.
- C. Apply coatings at spread rate required to achieve manufacturer's recommended dry film thickness.
- D. Regardless of number of coats specified, apply additional coats until complete hide is achieved.

3.04 PRIMING

- A. Apply primer to all surfaces unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.
- B. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to top coat manufacturers.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Clean surfaces immediately of overspray, splatter, and excess material.
- C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.06 PROTECTION

- A. Protect finished coatings from damage until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General requirements.

1.02 REFERENCE STANDARDS

- A. NEMA MG 00001 - Motors and Generators.
- B. NFPA 70 - National Electrical Code.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture of electric motors and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
- B. Comply with NFPA 70.
- C. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of high efficiency motors.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Baldor Electric Company/ABB Group.
- B. Allen-Bradley.
- C. Eaton.
- D. Square D.
- E. General Electric.

2.02 GENERAL CREQUIREMENTS

- A. Motor Requirements:
 - 1. Motors 1/2 HP and Smaller: single phase, 60 Hz unless indicated otherwise on the equipment schedules.
 - 2. Motors Larger than 1/2 Horsepower: three phase, 60 Hz unless indicated otherwise on the equipment schedules.
 - 3. All electronically commutated (EC) motors shall be complete with integral potentiometer, motor power input wire whip, and motor control input wire whip for 0-10 VDC control signal.
 - 4. All motors 1 HP and larger shall meet or exceed requirements of ASHRAE 90.1.
 - 5. All motors 1-1/2 HP and larger shall meet or exceed local utility requirements for high efficiency motors. Mechanical Contractor shall verify current requirements with utility.
 - 6. All motors used on variable frequency drives must be suitable for use with the drive, including but not limited to shaft grounding rings and motor cooling.
- B. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
- C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D. Starting Equipment:
 - 1. All starters shall be NEMA standard sizes and all starting equipment shall be of the same manufacturer.
 - 2. All starters, pushbuttons and selector switches shall have NEMA Type 1 enclosures.
- E. Starters

1. All manual starters shall be two pole for single phase fractional horsepower service with lockable on-off switch, hand-off-auto, power-run-fault indication lights, electronic overload protection, control system contacts, auxiliary dry contacts, manual-auto reset selection, fault relay, status relay, and power failure return mode.
 2. All magnetic starters shall be combination type with circuit breaker across the line for three phase service with reset button in cover, pilot light, overload protection for each phase, undervoltage protection, missing phase protection, phase reversal, built-in control circuit transformer with 120 volt operating coils and hand-off-auto selector switch factory mounted in starter flange.
 3. All starters shall be equipped with auxiliary contacts or control relays for equipment control interlocking as required.
- F. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

3.02 MECHANICAL CONTRACTOR

- A. Shall furnish all starting equipment including selector switches, relays, etc. They shall turn all manual and magnetic starters over to the Electrical Contractor with complete instructions and wiring diagrams required for a complete installation. All other control equipment shall be turned over to the Temperature Control subcontractor for installation.
- B. Shall furnish and install all control wiring.
- C. Shall confirm voltage requirements with the Electrical Contractor prior to ordering equipment.

3.03 ELECTRICAL CONTRACTOR

- A. Will furnish and install all fused and/or circuit breaker disconnect switches, except as indicated otherwise.
- B. Will furnish and install all power wiring from panel board to motors and junction boxes in factory-assembled units.

- C. Will install all starters in cooperation with and under the supervision of the Mechanical Contractor.

END OF SECTION

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Ball valves.
- B. Butterfly valves.
- C. Check valves.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- B. Section 23 07 16 - HVAC Equipment Insulation.
- C. Section 23 07 19 - HVAC Piping Insulation.
- D. Section 23 21 13 - Hydronic Piping.
- E. Section 23 22 13 - Steam and Condensate Heating Piping.

1.03 ABBREVIATIONS AND ACRONYMS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. TFE: Tetrafluoroethylene.
- I. WOG: Water, oil, and gas.

1.04 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
- B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
- D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- F. ASME B16.34 - Valves — Flanged, Threaded, and Welding End.
- G. ASME B31.9 - Building Services Piping.
- H. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.

- I. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- J. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
- K. AWWA C606 - Grooved and Shouldered Joints.
- L. MSS SP-68 - High Pressure Butterfly Valves with Offset Design.
- M. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves.
- N. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- O. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.06 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 - 5. Secure check valves in either the closed position or open position.
 - 6. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.

- b. Store valves off the ground in watertight enclosures when indoor storage is not an option.
- C. Exercise the following precautions for handling:
 - 1. Handle large valves with sling, modified to avoid damage to exposed parts.
 - 2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. See drawings for specific valve locations.
- B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
- C. Provide the following valves for the applications if not indicated on drawings:
 - 1. Isolation (Shutoff): Butterfly, Gate, and Ball.
 - 2. Swing Check (Pump Outlet):
 - a. Size 2 inch and Smaller: Bronze with bronze disc.
 - b. Size 2-1/2 inch and Larger: Iron with center-guided with resilient seat.
 - 3. Dead-End: Butterfly, single-flange (lug) type.
- D. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.
- E. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. Size 2 inch and Smaller: Threaded ends.
 - b. Size 2-1/2 inch and Larger: Grooved ends.
 - 2. Copper Tube:
 - a. Size 2 inch and Smaller: Threaded ends, except solder-joint valve-ends.
 - b. Size 2-1/2 inch and Larger: Grooved ends.
 - 3. Steam and Steam Condensate Pipe: Grooved ends not acceptable.
- F. Chilled Water Valves:
 - 1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Threaded or Solder Ends ends.
 - b. Ball: Full port, two piece, brass trim.
 - 2. Size 2-1/2 inch and Larger, Iron Valves:
 - a. 2-1/2 NPS to 4 NPS: Flanged ends.
 - b. Butterfly: High performance, single flange, Class 150.
- G. Heating Hot Water Valves:
 - 1. Size 2 inch and Smaller, Brass and Bronze Valves:
 - a. Threaded or Solder Ends ends.
 - b. Ball: Full port, two piece, stainless steel trim.

- c. Swing Check: Bronze disc, Class 125.
- 2. Size 2-1/2 inch and Larger, Iron Valves:
 - a. 2-1/2 inch to 4 inch: Threaded ends.
 - b. Butterfly: High performance, single flange, Class 150.
 - c. Center-Guided Check: Compact-wafer, metal seat, Class 125.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Gear Actuator: Quarter-turn valves 8 inch and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 inch and smaller.
- D. Valves in Insulated Piping: Provide 2 inch stem extensions and the following features:
 - 1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 2. Butterfly Valves: Extended neck.
- E. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 - 3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
 - 4. Solder Joint Connections: ASME B16.18.
 - 5. Grooved End Connections: AWWA C606.
- F. General ASME Compliance:
 - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 - 2. Building Services Piping Valves: ASME B31.9.
- G. Bronze Valves:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- H. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRASS, BALL VALVES

- A. Two Piece, Full Port with Stainless Steel Trim and Female Thread or Solder Connections:
 - 1. Comply with MSS SP-110.
 - 2. SWP Rating: 150 psi.
 - 3. WOG Rating: 600 psi.

4. Vacuum Rating: 28.9 in-Hg.
5. Body: Forged brass.
6. Seats: PTFE.
7. Stem: Stainless Steel.
8. Ball: stainless steel.
9. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. FNW; 410A: www.fnw.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 BRONZE, BALL VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Two Piece, Full Port with Stainless Steel Trim:
 1. Comply with MSS SP-110.
 2. WSP Rating: 150 psi.
 3. WOG Rating: 400 psi.
 4. Body: Forged bronze or dezincified-brass alloy.
 5. End Connections: Pipe thread or solder.
 6. Seats: PTFE.
 7. Stem: Stainless steel.
 8. Ball: Stainless steel, vented.
 9. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.
 - b. FNW; X450: www.fnw.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 HIGH-PERFORMANCE, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug type; Bidirectional dead end service without downstream flange:
 1. Comply with MSS SP-68.
 2. Class 150: CWP Rating: 285 psi at 100 degrees F.
 3. Body: Provide carbon steel, cast iron, ductile Iron, or stainless steel.
 4. Seat: Metal or reinforced PTFE.
 5. Offset stem: Stainless steel.
 6. Disc: Carbon steel.
 7. Operator: Lockable handle over direct-mount actuator base.

2.06 BRONZE, SWING CHECK VALVES

- A. Class 125:
 - 1. Pressure and Temperature Rating: MSS SP-80, Type 3.
 - 2. Design: Y-pattern, horizontal or vertical flow.
 - 3. WSP Rating: 200 psi.
 - 4. Body: Bronze, ASTM B62.
 - 5. End Connections: Threaded or soldered.
 - 6. Disc: Bronze.

2.07 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Compact-Wafer:
 - 1. Comply with MSS SP-125.
 - 2. Sizes 2-1/2 to 12 inch: CWP Rating; 200 psi.
 - 3. Body Material: ASTM A126, gray iron.
 - 4. Resilient Seat: EPDM or NBR.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

END OF SECTION

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. MFMA-4 - Metal Framing Standards Publication.
- B. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- C. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
- B. Manufacturers:
 - 1. B-Line, a brand of Eaton Corporation
 - 2. Gripple, Inc
 - 3. Unistrut, a brand of Atkore International Inc
- C. Hanger Rods:
 - 1. Threaded zinc-plated steel unless otherwise indicated.
 - 2. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Piping up to 1 inch: 1/4 inch diameter.
 - c. Piping larger than 1 inch: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- D. Beam Clamps:
 - 1. Forged steel concentric loaded type with tie rod to lock clamp in place for all piping 5" through 8". C type clamps may be used for piping smaller than 5".
- E. Riser Clamps:
 - 1. Furnish Grinnell Fig. 261 clamps to support vertical piping where required.
 - 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- F. Pipe Hangers:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation

- b. Gripple, Inc
 - c. Unistrut, a brand of Atkore International Inc
- 2. Furnish Grinnell Fig. 260 clevis type pipe hangers for all piping unless otherwise indicated.
- 3. Furnish Grinnell copper plated Fig CT-65 light duty adjustable wrought clevis copper tubing hangers for uninsulated copper tubing.
- 4. Furnish Grinnell Fig. 171 single pipe roll for all individual run hot piping 8" diameter and larger. For hot piping 1-1/2" diameter and larger and grouped on trapeze hangers or brackets, use Grinnell Fig. 274 adjustable pipe rolls. Note: Pipe rolls shall not be used closer than 20 ft. to a horizontal elbow.
- G. Pipe Saddles and Shields for Insulated Piping:
 - 1. Furnish Grinnell pipe covering protection saddles at all hanger locations on insulated hot piping 1-1/2" and larger.
 - 2. Furnish Grinnell Fig. 167 protection shields at all hanger locations on insulated piping smaller than 1-1/2".
 - 3. Furnish Grinnell Fig. 167 protection shields at all hanger locations on piping insulated with vapor barrier pipe covering.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Support all piping neatly and in an approved manner to allow for expansion, contraction and vibration. Piping shall be supported not more than 10 ft. between hangers and closer where required to prevent sagging or where required by local code, ordinance or the International Fuel Gas Code.
- C. On hot piping, smaller than 1-1/2", the hanger may be secured directly to the pipe and the pipe insulation surround the hanger.
- D. On hot piping, 1-1/2" and larger, the covering protection saddles specified above shall rest on the pipe insulation and the hanger shall surround the outside of the pipe insulation and protection saddles specified.
- E. On all cold piping with vapor barrier insulation, the covering protection shields specified above shall rest on the pipe insulation and the hanger shall surround the outside of the pipe insulation and sheet metal protection shields specified.

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- F. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- G. Unless specifically indicated or approved by the Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- H. Unless specifically indicated or approved by the Engineer, do not provide support from roof deck.
- I. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- J. Remove all new or existing temporary supports.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Pipe markers.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturers catalog literature for each product required.
- C. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Equipment: Nameplates.
- B. Air Terminal Units: Nameplates.
- C. Control Panels: Nameplates.
- D. Ductwork: Adhesive-Backed Duct Markers.
- E. Major Control Components: Nameplates.
- F. Piping: Pipe markers.
- G. Pumps: Nameplates.
- H. Valves: Tags.
- I. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

- A. Plastic: Comply with ASTM D709.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.

2.03 TAGS

- A. Plastic Tags: Engraved three-layer.
 - 1. Letter Color: White
 - 2. Letter Height: 1/4 inch (Minimum)
 - 3. Background Color: Black.

4. Tag size: 1-1/2 inch diameter (Minimum)

2.04 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B. Style: Individual Label.
- C. Color: Green/White.

2.05 PIPE MARKERS

- A. Color: Comply with ASME A13.1.
- B. Plastic Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install nameplates with adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
 1. Identify service, flow direction, and pressure.
 2. Install in clear view and align with axis of piping.
 3. Locate identification not to exceed 20 feet on straight runs including risers and drops.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
- C. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 2. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 3. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 4. Units of Measure: Report data in I-P (inch-pound) units only.
 - 5. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.

2. NEBB, National Environmental Balancing Bureau.
3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 2. Having minimum of three years documented experience.
 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 1. Systems are started and operating in a safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place.
 15. Service and balance valves are open.

- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- B. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

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

3.05 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 SCOPE

- A. Test, adjust, and balance the following (New and Existing):
 - 1. HVAC Pumps.
 - 2. Packaged Roof Top Heating/Cooling Units.

3. Air Coils.
4. Terminal Heat Transfer Units.
5. Air Handling Units.
6. Fans.
7. Air Terminal Units.
8. Air Inlets and Outlets.

3.09 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 1. Manufacturer.
 2. Model/Frame.
 3. HP/BHP.
 4. Phase, voltage, amperage; nameplate, actual, no load.
 5. RPM.
 6. Service factor.
 7. Starter size, rating, heater elements.
 8. Sheave Make/Size/Bore.
- B. V-Belt Drives:
 1. Identification/location.
 2. Required driven RPM.
 3. Driven sheave, diameter and RPM.
 4. Belt, size and quantity.
 5. Motor sheave diameter and RPM.
- C. Pumps:
 1. Identification/number.
 2. Manufacturer.
 3. Size/model.
 4. Impeller.
 5. Service.
 6. Design flow rate, pressure drop, BHP.
 7. Actual flow rate, pressure drop, BHP.
 8. Discharge pressure.
 9. Suction pressure.
 10. Total operating head pressure.
 11. Shut off, discharge and suction pressures.
 12. Shut off, total head pressure.
- D. Existing Heating Coils:
 1. Identification/number.

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2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.
9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

E. Air Moving Equipment:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Arrangement/Class/Discharge.
6. Air flow, specified and actual.
7. Return air flow, specified and actual.
8. Outside air flow, specified and actual.
9. Total static pressure (total external), specified and actual.
10. Inlet pressure.
11. Discharge pressure.
12. Water pressure drop, design and actual. Entering water temperature, design and actual. Leaving water temperature, design and actual.
13. Entering water temperature, design and actual. Leaving water temperature, design and actual.
14. Sheave Make/Size/Bore.
15. Number of Belts/Make/Size.
16. Leaving water temperature, design and actual.
17. Fan RPM.
18. Water pressure drop, design and actual. Entering water temperature, design and actual. Leaving water temperature, design and actual.
19. Entering water temperature, design and actual. Leaving water temperature, design and actual.
20. Leaving water temperature, design and actual.

F. Exhaust and supply Fans:

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1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
9. Sheave Make/Size/Bore.
10. Number of Belts/Make/Size.
11. Fan RPM.

G. Air Monitoring Stations:

1. Identification/location.
2. System.
3. Size.
4. Area.
5. Design velocity.
6. Design air flow.
7. Test velocity.
8. Test air flow.

H. Terminal Unit Data:

1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.
5. Model number.
6. Size.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.
12. Water pressure drop, design and actual. Entering water temperature, design and actual. Leaving water temperature, design and actual.
13. Entering water temperature, design and actual. Leaving water temperature, design and actual.

14. Leaving water temperature, design and actual.

END OF SECTION

SECTION 23 07 13 - DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.

1.02 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- E. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of experience and approved by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. CertainTeed Corporation
 - 2. Johns Manville
 - 3. Knauf Insulation
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 1,200 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E. The entire assembly shall provide a minimum "installed R value" of 6 for all indoor ductwork.
- F. The entire assembly shall provide a minimum "installed R value" of 10 for all outdoor ductwork.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. CertainTeed Corporation
 - 2. Johns Manville
 - 3. Knauf Insulation
- B. Insulation: ASTM C612; rigid, noncombustible blanket.

1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 450 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent.
 4. Maximum Density: 8.0 pcf.
- C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E. The entire assembly shall provide a minimum "installed R value" of 6 for all indoor ductwork.
- F. The entire assembly shall provide a minimum "installed R value" of 10 for all outdoor ductwork.

2.04 DUCT LINER

- A. Manufacturers:
1. CertainTeed Corporation
 2. Johns Manville
 3. Knauf Insulation
- B. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
1. Fungal Resistance: No growth when tested according to ASTM G21.
 2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 3. Service Temperature: Up to 250 degrees F.
 4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
 5. Minimum size:
 - a. 1 inch Thickness: Return, transfer and exhaust ductwork.
 - b. 2 inch Thickness: Supply ductwork.
- C. Adhesive: Waterproof, fire-retardant type, ASTM C916.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test ductwork for design pressure prior to applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Insulated Ducts Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated Ducts Conveying Air Above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. Duct Liner Application:
 - 1. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
 - 2. Seal and smooth joints. Seal and coat transverse joints.
 - 3. Seal liner surface penetrations with adhesive.
 - 4. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

- A. Exhaust Ducts: 1" glass fiber, rigid from automatic air damper to roof or wall termination (except where ductwork is lined).
- B. Outside Air Intake Ducts: 2" glass fiber, rigid.
- C. Supply Ducts: 2" glass fiber, flexible; 2" duct liner where indicated.
- D. Supply Ducts in Mechanical Rooms: 2" glass fiber, rigid.
- E. Return and Exhaust Ducts: 1" duct liner where indicated.
- F. Return and Exhaust Ducts in Mechanical Rooms: 1" glass fiber, rigid.

END OF SECTION

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.

1.03 REFERENCE STANDARDS

- A. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- D. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER

- A. Manufacturers:

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1. CertainTeed Corporation
2. Johns Manville Corporation
3. Knauf Insulation
4. Owens Corning Corporation

B. Hot Piping:

1. Complete with flame retardant kraft reinforced foil all service white jacket. Jacket shall have a factory applied double pressure sensitive adhesive to adhesive closure flap. Circumferential end joints shall be sealed with self-sealing 3" wide kraft reinforced foil white butt strips.
2. All valve bodies, flanges, clamp type pipe couplings and fittings shall be wrapped with fiberglass blanket, or segments of pipe insulation securely tied in place to a thickness slightly greater than the adjoining insulation. Wrap Manville "Zerotape" over the insulation and finish with an open weave glass cloth imbedded in two coats of Benjamin Foster No. 30-36 or Childers CP-50 fire resistive white sealer.
3. Premolded one piece 25/50 rated PVC insulated fitting covers may be used in lieu of insulating cement and glass cloth at valve bodies, flanges, clamp type couplings and fittings. Factory pre-cut fiberglass insulation shall be applied to the fitting with the insulation tucked into the throat of the fitting and the edges of the adjacent pipe covering. The PVC cover shall be applied and secured by stapling and applying pressure sensitive tape over the staples and at the circumferential edges.
4. Vertical soft copper tubing concealed in building construction shall be covered with Armaflex AP, Aeroflex or Rubatex flexible, plenum rated, antimicrobial, closed cell elastomeric foam pipe insulation. All joints and seams are to be sealed with Armaflex 520 BLV low VOC adhesive or equal.

C. Cold Piping:

1. Complete with flame retardant kraft reinforced foil all service white vapor barrier jacket. Jacket shall have a factory applied double pressure sensitive adhesive to adhesive closure flap. Circumferential end joints shall be sealed with 3" wide self-sealing kraft reinforced foil vapor barrier white butt strips.
2. All valve bodies, flanges, clamp type pipe couplings and fittings shall be wrapped with fiberglass blanket, or segments of pipe insulation securely tied in place to a thickness slightly greater than the adjoining insulation. Wrap Manville "Zerotape" over the insulation and finish with an open weave glass cloth imbedded in two coats of Benjamin Foster No. 30-36 or Childers CP-50 fire resistive white sealer.

3. Premolded one piece 25/50 rated PVC insulated fitting covers may be used in lieu of insulating cement and glass cloth at valve bodies, flanges, clamp type couplings and fittings. Factory pre-cut fiberglass insulation shall be applied to the fitting with the insulation tucked into the throat of the fitting and the edges of the adjacent pipe covering. The PVC cover shall be applied and secured by stapling and applying vapor barrier pressure sensitive tape over the staples and at the circumferential edges. The tape shall have an overlap on itself of at least 2". All seam edges of the cover shall be sealed with vapor barrier adhesive.
4. At each pipe hanger location, provide half-round, 6" long, hanger block at the bottom half of the piping in place of the pipe insulation. The hanger blocks shall be wood or asbestos free calcium silicate pipe insulation of the same thickness as the adjoining pipe insulation. The vapor barrier jacket shall be continuous through the hanger location and a 16 gauge 12" long galvanized sheet steel saddle shall be wrapped around the pipe insulation between the jacket and the hanger.
5. Entire installation shall be vapor proof. Any breaks, rips, tears or omission of vapor barrier shall be repaired.

D. Hot Equipment:

1. One and one half inch (1-1/2") thickness 3 lbs. per cu. ft. density fiberglass semi-rigid board insulation with factory applied aluminum foil reinforced kraft facing. Insulation shall be adhered to the surfaces with fire resistive adhesive (100% coverage). All edges and joints shall be sealed with 3" wide reinforced aluminum foil pressure sensitive joint sealing tape. All flaps shall be pasted and sealed with Benjamin-Foster No. 85-20 or Childers CP-82 fire resistive white adhesive. Completely cover the insulation with a heavy coat of Benjamin-Foster 30-36 Sealfas or Childers CP-50. Imbed an open weave glass cloth and while still wet apply a finish coat of Benjamin-Foster 30-36 or Childers CP-50 fire resistive white sealer.
2. Type of Equipment:
 - a. Air and Dirt Separators.

2.03 ACCESSORIES

A. General Requirements:

1. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
2. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
3. Supply materials that are asbestos free.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- E. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- F. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
- G. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.
- H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Minimum R-4 per inch.

2. Heating Water Supply and Return:
 - a. One and one-half inch (1-1/2") thickness on piping 1-1/2" and less.
 - b. Two inch (2") thickness on piping 2" and larger.
- B. Cooling Systems:
 1. Minimum R-4 per inch.
 2. Chilled Water:
 - a. One and one-half inch (1-1/2") thickness on piping 1-1/2" and less.
 - b. Two inch (2") thickness on piping 2" and larger.
 3. Water piping installed by this Contractor:
 - a. Three quarter inch (3/4") thickness on piping 2" and less.
 - b. One inch (1") thickness on piping 2-1/2" and larger.

END OF SECTION

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DDC INPUT / OUTPUT SUMMARY TABLE

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	Control Relay	24VAC	Contact	2-Pos Actuator	Tri-State Actuator	Duration Adjust Actuator	1-44-5VDC	0(2)-10 VDC	Current Sensing Switch	Control Relay Contact	Switch Closure	Auxiliary Contact	Diff Pressure Switch	Flow Switch	Temperature	Relative Humidity	Differential Pressure	0-5VDC	Static Pressure	Flow	Equipment Status	Maintenance	Pressure	High Limit	Low Limit	Maintenance	Day/Night Setback	Demand Limiting	Dial-up I/O	Duty Cycling	Optimum Start/Stop	Scheduled Start/Stop	Totalization	Trend	Equipment Integration	Fire Alarm Integration	Security/Access Integration	Elect PQM Integration	Chiller Integration	Dry-bulb Economizer	HW/OA Reset	CHW Reset	Smoke Control	Fire Alarm Override																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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DDC INPUT / OUTPUT SUMMARY TABLE

Sauk County Courthouse HVAC and Lighting Upgrades Project No. 2025012	HARDWARE														SOFTWARE																																				
	OUTPUT				INPUT								ALARMS																																						
	DIGITAL		ANALOG		DIGITAL				ANALOG				DIGITAL		ANALOG		ENERGY MANAGEMENT SYSTEM FUNCTIONS																																		
	Control Relay	24VAC	Contact	2-Pos Actuator	Tri-State Actuator	Duration Adjust Actuator	4-20 mA	0-10 VDC	Current Sensing Switch	Control Relay Contact	Switch Closure	Auxiliary Contact	Diff Pressure Switch	Flow Switch	Temperature	Relative Humidity	Differential Pressure	Gauge Pressure	Static Pressure	Flow	Equipment Status	Maintenance	Pressure	High Limit	Low Limit	Maintenance	Day/Night Setback	Demand Limiting	Dial-up I/O	Duty Cycling	Optimum Start/Stop	Scheduled Start/Stop	Totalization	Trend	Equipment Integration	Fire Alarm Integration	Security/Access Integration	Elect PQM Integration	Chiller Integration	Dry-bulb Economizer	HW/OA Reset	CHW Reset	Smoke Control	Fire Alarm Override	Comments						
SYSTEM: AHU-1,2,3, RAHU-1,2 (mixed air VAV electrically actuated)															X																																				
POINT DESCRIPTION																																																			
Supply Air Temperature															X									X	X									X																	
Mixed Air Temperature															X								X	X										X																	
Return Air Temperature															X								X	X										X																	
Return Air Rel Humidity																X							X	X										X																	
Heating Coil Valve							X																																												
Heating Coil Pump Start/Stop	X																					X													X																
Heating Coil Pump Status								X														X													X																
Chilled Water Coil Valve							X																												X																
Chilled Water Coil Temperature															X								X	X										X																	
Return Air Damper							X																												X				X												
Relief Air Damper							X																												X				X												
Outdoor Air Damper							X																												X				X												
Minimum OA Flow																			X				X	X										X																	
Supply Fan VFD Speed							X																																												
Supply Fan VFD Fault																						X															X														
Supply Fan Status								X														X													X																
Supply Fan Start/Stop	X																																X	X																	
Supply Air Static Pressure																		X					X												X																
Relief Fan VFD Speed							X																																												
Relief Fan VFD Fault																						X														X															
Relief Fan Status								X														X													X																
Relief Fan Start/Stop	X																																X	X																	
Building Static Pressure																		X					X												X																
Prefilter Differential Pressure																	X						X		X																										
Final-filter Differential Pressure																X							X		X																										
High Press Static Shutdown											X											X		X																											
Freeze Stat											X											X																													Electric freezestat
Fire Alarm Shutdown											X											X																													X

DDC INPUT / OUTPUT SUMMARY TABLE

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DDC INPUT / OUTPUT SUMMARY TABLE

Sauk County Courthouse HVAC and Lighting Upgrades Project No. 2025012	HARDWARE														SOFTWARE																																		
	OUTPUT							INPUT							ALARMS																																		
	DIGITAL			ANALOG				DIGITAL			ANALOG				DIGITAL	ANALOG			ENERGY MANAGEMENT SYSTEM FUNCTIONS																														
	Control Relay	Solenoid	Contact	24 VAC	Tri-State Actuator	Duration Adjust Actuator	4-20 mA	0-10 VDC	Current Sensing Switch	Control Relay Contact	Switch Closure	Auxiliary Contact	Diff Pressure Switch	Flow Switch	Temperature	Resistive	Differential Pressure	Actuator Feedback	CO2	Flow	Equipment Status	Maintenance	Pressure	High Limit	Low Limit			Day/Night Setback	Demand Limiting	Dial-up I/O	Duty Cycling	Optimum Start/Stop	Scheduled Occ/Unoc	Totalization	Trend	Redundancy Control	Lighting Integration	Fire Alarm Integration	Security/Access Integration	Elect PQM Integration	Chiller Integration	CFM Offset	OA Lockout	CHW Reset	Smoke Control	Fire Alarm Override	Comments		
SYSTEM: VAV, HW Heating Coils																																																	
POINT DESCRIPTION																																																	
VAV																																																	
Zone Temperature															X										X	X								X															
Temperature Setpoint Adjust																X			X																														
Supply Air Damper ^{1 & 2}					X	X	X	X										X																															
Supply Air Flow																				X															X														
Discharge Air Temperature															X																				X														
Reheat Valve								X									X																		X														
Radiant Heat Valve					X		X																																										
Occupancy Sensor											X																																						
Zone Heating Coils																																																	
Zone Temperature															X										X	X									X														
Temperature Setpoint Adjust																X																																	
Reheat Valve							X											X																	X														

Notes:

1. Analog outputs must utilize a calculated proportional command from software. Actual output can be any type but floating outputs shall have a means of indicating actual actuator position to BAS
2. Damper actuators can utilize stepper type motors.

SECTION 23 09 23 - DIRECT DIGITAL CONTROL (DDC) SYSTEMS

(FOR INFORMATIONAL PURPOSES ONLY)

PART 1 GENERAL

2.01 SCOPE

- A. The work associated with this section WILL NOT be bid as part of the Division 23 scope of work.
- B. Work in this section includes Direct Digital Control (DDC) panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a completely coordinated extension of the existing campus or building Direct Digital Control (DDC) system. This system interfaced with pneumatic/electric controls (Section 23 09 54) utilizing Direct Digital Control signals to operate actuated control devices will meet, in every respect, all operational and quality standards specified herein, a fully coordinated modification and extension via DDC of the existing Central Campus Automation System.

2.02 RELATED WORK

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Section 23 09 15 – DDC Points List
- C. Section 23 09 54 –Electric Temperature Control System.
- D. Section 23 09 93 - Automatic Control Sequences.
- E. Division 23 - HVAC - Equipment provided to be controlled or monitored
- F. Division 26 - Electrical - Equipment provided to be controlled or monitored

2.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

2.04 REFERENCE STANDARDS

- A. FCC Part 15, Subpart J, Class A - Digital Electronic Equipment to Radio Communication Interference

2.05 WORK NOT INCLUDED

- A. Section 23 09 54 work includes furnishing and installing all field devices, including electronic sensors for the DDC of this section, equipment, and all related field wiring, interlocking control wiring between equipment, pneumatic tubing, sensor mounting, etc., that is covered in that section.
- B. Motorized control dampers and actuators, thermowells (temperature sensing wells), automatic control valves and their actuators are also covered in Section 23 09 54.

2.06 QUALITY ASSURANCE

- A. Manufacturer:

1. Johnson Controls Metasys, utilizing BACnet communication protocol.
- B. Original Equipment Manufacturer (OEM) Controller DDC Integration: Where factory-packaged controls are furnished for DDC of HVAC equipment and devices, a manufacturer's branch office or an authorized representative of the equipment manufacturer shall provide start-up and check-out of equipment and shall work with this contractor for integration to the Building Automation System (where integration is specified). OEM shall provide tech support as needed until integration is complete and operating reliably.
- C. Installer:
 1. A firm specializing and experienced in DDC control system installation for no less than 3 years. All engineering and commissioning work shall be done by qualified employees of this manufacturer, or qualified employees of an Authorized Representative of that manufacturer that provides engineering and commissioning of the manufacturer's control equipment. Where installing contractor is an authorized representative of the control equipment manufacturer, submit written confirmation of such authorization. Indicate in letter of authorization that the installing contractor has successfully completed all necessary training required for the engineering, installation, and commissioning of equipment and systems to be provided for the project and that such authorization has been in effect for a period of not less than three years. The letter of authorization should also indicate that the installing contractor is authorized to install the manufacturer's DDC equipment at the project location at the time the project is bid. Installation of the equipment shall be done by qualified mechanics and/or electricians in the direct employ or be directly subcontracted and under the supervision of the manufacturer or Authorized Representative. The contractor providing and installing the equipment under this specification section shall be the same contractor providing and installing equipment under the 23 09 54 specification section.
- D. Response Time:
 1. During warranty period, 4 hours or less, 24-hours/day, 7 days/week.
- E. Electrical Standards:
 1. Provide electrical products, which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.
 2. DDC Standards: DDC manufacturer shall provide written proof with shop drawings that the equipment being provided is in compliance with F.C.C. rules governing the control of interference caused by Digital Electronic Equipment to Radio Communications (Part 15, Subpart J, Class A).

2.07 SUBMITTALS

- A. The following sections shall be submitted together as one package: 23 09 15, 23 09 23, 23 09 54, and 23 09 93. All four specification sections shall be referenced on submittal cover page and paperwork. Include the following information (see 23 09 54 for additional requirements):
1. Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Indicate which piece of mechanical equipment is associated with each controller and what area within the building is being served by that equipment. For terminal unit control, provide a room schedule that would list mechanical equipment tag, room number of space served, address of DDC controller, and any other pertinent information required for service.
 2. A schedule of all inputs and outputs associated with DDC controllers for project.
 3. Sequence of operations for all DDC equipment, including Original Equipment Manufacturer DDC packaged controllers. It is this contractor's responsibility to obtain the OEM equipment sequence and include it in the submittal package so all DDC under the Building Automation System can be referenced in one, cohesive package.
 4. **PRODUCT DATA**
 - a. Submit manufacturer's specifications for each control device furnished, including installation instructions and startup instructions. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked. Actual system sequences, along with descriptive narratives of the sequence of operation of the entire system involved. Submit wiring diagram for each electrical control device along with other details required to demonstrate that the system has been coordinated and will function as a system.
 5. **MAINTENANCE DATA**
 - a. Submit maintenance data and spare parts lists for each control device. Include this data in maintenance manual.

2.08 RECORD DRAWINGS

- A. Prior to request for final payment provide complete composite record drawings to incorporate the DDC and Pneumatic/Electric field work. Accurate Section 23 09 54 record drawings to be supplied by the Section 23 09 54 contractor with the accuracy of these drawings being the responsibility of the 23 09 54 contractor. In the event that changes are required to the 23 09 54 supplied record drawings after they have been compiled by the 23 09 23 contractor, it shall be the 23 09 54 contractor's responsibility to provide updated composite record drawings incorporating the 23 09 23 record drawings.

- B. All software addressing for device communication shall be noted for all devices provided under this section and the communication addressing required for devices provided by others that are integrated into the direct digital control system provided under this section. Point to point routing of communication trunks and power wiring between DDC controllers, DDC communication devices, control panels, and Ethernet switches shall be documented. For systems that have additions to existing communication networks, provide complete DDC network diagrams for the communication trunk affected with new work clearly delineated. Coordinate with the supplier of the equipment specified to be interfaced through digital communications for communication addressing. Provide circuit number of 120VAC panel power circuit(s) feeding each control panel on record drawings. Label circuit number(s) inside the panel served.
- C. Any supervisory controller (new or existing) is to be identified by its controller type, controller address and communication trunk type and controller location. It shall also identify all (new or existing) field controllers by controller type, controller address and communication trunk type and controller location. Asbuilts of controller-to-controller communication trunk and network trunk layout must be provided.
- D. Operation and Maintenance Data:
 - 1. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.
 - 2. In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:
 - a. Provide signed and dated commissioning sheets. Commissioning sheets shall include both DDC point-to-point checkoff (confirming all DDC points are accurate and operable) and Functional Performance Testing checkoff sheets (confirming equipment operates according to sequence of operations). These are required in addition to any general commissioning requirements specified elsewhere.
 - b. In each temperature control panel, provide a copy of the control drawings that pertain to equipment served by the temperature control panel. This should include a flow schematic of the system(s) served, the control panel and field wiring diagrams (furnished by 23 09 54), and the sequence of operations.

2.09 MATERIAL DELIVERY AND STORAGE

- A. Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

PART 2 PRODUCTS

3.01 GENERAL

- A. Provide DDC control products in sizes and of capacities as required, conforming to manufacturer's standard materials and components as published in their product information, designed and constructed as recommended by the manufacturer and as required for application indicate.
- B. System shall be capable of operating with 120 VAC power supply, fully protected with a shutdown-restart circuit, and associated hardware and software.

3.02 LOCAL CONTROL PANELS

- A. Use control panels with suitable mounting brackets for each supply fan system. Locate panel adjacent to system served or where shown on plans.
- B. Fabricate panels of 14 gauge furniture grade steel or 6063-T5 extruded aluminum alloy, totally enclosed on six sides, hinged door and keyed lock, with manufacturer's standard shop painted finish and color.
- C. Provide UL listed cabinets for use with line voltage devices.
- D. Control panels that have devices or terminations that are fed or switch 50V or higher shall enclose the devices, terminations, and wiring so that Personal Protective Equipment (PPE) is not required to service the under 50V devices and terminations within the control panel. As an alternative, a separate panel for only the 50V and higher devices may be provided and mounted adjacent to the under 50V control panel.
- E. Plastic control enclosures will be approved provided all conduits are bonded and grounded.
- F. Provide control panels for all DDC Controllers, ASC's and associated function modules. All controls to be in control panels provided under this Section except for the following:
 - 1. Terminal unit controllers mounted within the terminal unit equipment enclosure
 - a. or above/beneath accessible lay-in tile ceilings/floors where VAV box controllers designed to be directly mounted on air terminals.
 - 2. Above/below accessible lay-in tile ceilings/floors where additional controllers are required for air terminal unit control. Where additional controllers are required, they shall not be mounted directly to the ductwork but be mounted on din rail or back panel in an accessible location as close as possible to the terminal unit(s) being controlled.
- G. Provide terminal unit equipment enclosures with removable cover for all terminal units located in exposed ceilings or in mechanical rooms that completely enclose the DDC controller and allow for conduit terminations.
- H. All wiring for controllers shall be managed in a neat and workmanlike manner.

- I. Permanently label all controls: Tag all control wiring with associated DDC point name. If wiring is not associated with DDC point name, tag control wiring with an intuitive name indicating its purpose, and document on all control drawings.

3.03 DIRECT DIGITAL CONTROLS

- A. System to be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.
- B. DDC to consist of Supervisory Controllers, Programmable Controllers, stand-alone Application Specific Controllers (ASC's), Operators Terminals, Operator Workstations, DDC system servers, and other operator interface devices.
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.
- D. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

3.04 NETWORKING/COMMUNICATIONS

- A. The design of the DDC shall be networked. The highest level networking shall use Ethernet and the sub-level networking shall use serial communications. Inherent in the system's design shall be the ability to expand or modify the highest network either via a local area network (LAN), wide area network (WAN), or a combination of the two schemes.
- B. The highest-level DDC communications network shall be capable of direct connection to and communication with a high-speed LAN or WAN utilizing an Ethernet connection.
Communication protocol used shall be BACnet/IP.
- C. The supervisory controller shall directly oversee a local network such that communications may be executed directly to and between programmable controllers and ASC's. All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all points and application reports on the network.
- D. Provide serial communication ports on all ASC's for operator's terminal communications with the DDC Controller.
- E. Access to system data shall not be restricted by the hardware configuration of the DDC system.
- F. Global data sharing or global point broadcasting shall allow point data to be shared between programmable controllers and ASC's when it would be impractical to locate multiple sensors.
- G. BACnet Requirements:
 1. BACnet of highest level network communications will utilize BACnet/IP over Ethernet and field level communications shall utilize BACnet MSTP. No other communication protocol is acceptable.

2. All controllers shall provide a Protocol Implementation Conformance Statement (PICS) and BACnet Interoperability Building Blocks (BIBB"S) as required by the American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ANSI/ASHRAE) Standard 135-2001, BACnet protocol.
- H. Supervisory controllers shall be microprocessor-based, multi-tasking, multi-user and digital control processors.
- I. Each supervisory controller shall have sufficient memory to support its own operating system and databases including:
 1. Control processes.
 2. Energy management application.
 3. Alarm management.
 4. Trend data.
 5. Maintenance support applications.
 6. Operator I/O.
 7. Dial-up communications.
 8. Manual override monitoring.
- J. The system shall be modular in nature, and shall permit easy expansion through the addition of field controllers, sensors, and actuators.
- K. Supervisory controllers shall provide at least two RS-232C or USB serial communication ports or Ethernet ports for simultaneous operation of multiple operator I/O devices, such as laptop computers, personal computers, and video display terminals.
- L. Supervisory controllers shall monitor the status of all overrides and include this information in the logs and summaries to inform the operator that automatic control has been inhibited.
- M. Each supervisory controller shall continuously perform self-diagnostics, communications diagnostics, and diagnostics of all subsidiary equipment. Supervisory controllers shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each supervisory controller.
- N. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high to allow all signal wiring to be run in the same conduit as high voltage wiring acceptable by electrical code.
- O. In the event of the loss of normal power, there shall be an orderly shutdown of the supervisory controller to prevent the loss of data base 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 72 hours.

- P. Upon restoration of normal power, the supervisory controller shall automatically resume full operation without manual intervention.
- Q. Should supervisory controller memory be lost for any reason, the supervisory controller shall have the capability of reloading it's programming via high speed local area network from the control system archive workstation or server, the local RS-232C port, or telephone line dial-in.

3.05 SYSTEM SOFTWARE FEATURES

- A. All necessary software to form a complete operating system, as described in this specification, shall be provided as an integral part of the supervisory controller, and shall not be dependent upon higher level computer for execution.
- B. Control software shall include a provision for limiting the number of times that each piece of equipment may be cycled within any one-hour period.
- C. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
- D. Supervisory controllers shall have the ability to perform any or all of the following energy management routines:
 - 1. Time of day scheduling.
 - 2. Calendar based scheduling.
 - 3. Holiday scheduling.
 - 4. Optimal start.
 - 5. Optimal stop.
 - 6. Demand limiting.
 - 7. Load rolling.
 - 8. Heating/cooling interlock.
- E. All programs to be executed automatically without the need for operator intervention, and be flexible enough to allow user customization. Programs shall be applied to building equipment described in Section 23 09 93 of this specification.
- F. Supervisory controllers shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.
- G. It shall be possible to use any of the following in a configured process:
 - 1. Any system-measured point data or status.
 - 2. Any calculated data.
 - 3. Any results from other processes.
 - 4. Boolean logic operators (and, or).
- H. Configured processes may be triggered based on any combination of the following:
 - 1. Time of day.
 - 2. Calendar date.

3. Other processes.
4. Events (e.g., point alarms).
- I. A single process shall be able to incorporate measured or calculated data from any and all other ASC's.
- J. A single process shall be able to issue commands to points in any and all other programmable controllers and ASC's on the local network.
- K. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each supervisory controller shall perform distributed; independent alarm analysis and filtering to minimize network traffic and prevent alarms from being lost. At no time shall the ability of supervisory controllers to report alarms be affected by either operator activity at the local I/O device or communications with other ASC's on the network.
- L. All alarm or point change reports shall include the English language description of each point and the time and date of the occurrence.
- M. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point.
- N. The user shall also be able to define conditions under which point changes need to be acknowledged by an operator and/or logged for analysis at a later date.
- O. Alarms reports and messages shall be directed to an operator device.
- P. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 60-character alarm message to more fully describe the alarm condition or direct operator response.
- Q. Each supervisory controller shall be capable of storing a library of at least 100 messages. Each message may be assignable to any number of points in the panel.
- R. A data collection utility shall be provided to automatically sample, store, and display system data.
- S. Measured and calculated analog and binary data shall be assignable to user definable trends for the purpose of collecting operator specified performance data over extended periods of time. Sample intervals of 1 minute to 24 hours, in one minute or one hour intervals, shall be provided. Each supervisory controller shall have a dedicated buffer for trend data and shall be capable of storing 16 trend logs. Each trend log shall have up to four points trended at 48 data samples each. Data shall be stored at the supervisory controller and up-loaded to the DDC system server when archiving is desired.
- T. Supervisory controllers shall automatically accumulate and store runtime hours for binary input and output points, specified in Sections 23 09 15 and 23 09 54, of this specification.

- U. Supervisory controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis, user defined, for user-selected analog and binary pulse input type points.
- V. Totalization shall provide calculation and storage accumulations of up to 9,999,999 units (e.g., KWH, gallons KBTU, tons, etc.).
- W. The totalization routine shall have a sampling resolution of one minute.
- X. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.
- Y. The information available from pulse totalization shall include, but not be limited to, the following:
 - 1. Peak demand, with date and time stamp.
 - 2. 24-hour demand log.
 - 3. Accumulated KWH for day.
 - 4. Sunday through Saturday KWH usage.
 - 5. Demand KW annual history for past 12 periods.
 - 6. KWH annual history for past periods.
- Z. Supervisory controllers shall have the ability to count events, such as the number of times a pump or fan system is cycled on and off.
- AA. The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

3.06 PROGRAMMABLE CONTROLLERS

- A. Programmable controllers shall be provided with a software program that shall allow the user to design flexible software algorithms for the control sequences as described in Sections 23 09 54 and 23 09 93, portions of this specification.
- B. Programmable controllers shall support all necessary point inputs and outputs to perform the specified control sequence in a totally stand-alone fashion.
- C. Each programmable controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.
- D. Each programmable controller shall support the use of a locally mounted status and adjust panel interface to allow for the local adjustment of all setpoints, temporary override of any input or output points and status of all points directly at the controller. The capabilities of the locally mounted status and adjust panel shall include, but not be limited to, the following information for the programmable controllers to which:
 - 1. Display temperatures.
 - 2. Display status.
 - 3. Display setpoints.
 - 4. Display control parameters.

5. Override binary output control.
 6. Override analog output control.
 7. Override analog setpoints.
 8. Modification of gain and offset constants.
- E. All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the programmable controller.
- F. Programmable controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 54 and 23 09 93, portions of this specification:
1. Mixed air handling units.
 2. hot water heating systems with pump logic.

3.07 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS

- A. Each supervisory controller shall be able to extend its monitoring and control through the use of stand-alone application specific controllers (ASC's).
- B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor based, multi-tasking, real-time digital control processor.
- C. Each ASC shall have sufficient memory to support its own operating system and databases including:
1. Control Processes.
 2. Energy Management Applications.
 3. Operator I/O (Portable Service Terminal).
- D. The operator interface to any ASC point or program shall be through the supervisory controller connection to any ASC on the network.
- E. ASC's shall directly support the temporary use of a portable service terminal that can be connected to the ASC via zone temperature or directly at the controller. The capabilities of the portable service terminal shall include, but not be limited to, the following information for the:
1. Display temperatures.
 2. Display status.
 3. Display setpoints.
 4. Display control parameters.
 5. Override binary output control.
 6. Override analog output control.
 7. Override analog setpoints.
 8. Modification of gain and offset constants.

- F. All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.
- G. ASC's shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 54 and 23 09 93, portions of this specification, and for future expansion of air handling units:
 - 1. Variable Air Volume Terminals.
 - 2. Reheat Terminals.
 - 3. Fan Coils.
 - 4. Unit Ventilators.
 - 5. Packaged Air Handling Units.
- H. For butterfly type Variable Air Volume (VAV) Terminals, provide differential pressure transducers and damper actuators for flow measurement and actuation of the VAV terminal damper. Pressure transducers for VAV box flow applications do not need to have adjustable pressure ranges or integral display. Provide filter on high side of flow pickups if flow measurement device requires airflow through the device. All differential pressure transducer inputs for airflow measurement shall have a method to compensate for sensor drift to calibrate the zero point of the input. The differential pressure transducers and damper actuators can be integrated into the terminal unit controller or be discrete devices.
- I. Provide a method to view and print a summary of current K-factors for flow correction for each VAV terminal through the DDC system. The summary shall have a minimum of 50 K-factors per group of VAV terminals.
- J. All system setpoints, proportional bands, control algorithms, calibration constants, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.
- K. All application specific controllers shall be fully programmable. Question and answer or template programming is not acceptable unless this is used to generate the initial application program and the result is able to be freely modified without restriction. Control sequences for terminal unit control that utilize devices wired directly to the terminal unit application controller shall be programmed in the application specific controller and shall be stand-alone in function, i.e. occupancy sensing, temperature setpoint setback, etc. Supervisory controllers shall not be involved in the control sequence logic unless it involves sharing data between or from individual terminal unit controllers to be utilized in a global sequence, i.e. trim and respond strategies, terminal unit grouping, etc.

3.08 OPERATOR INTERFACE REQUIREMENTS

- A. Text-based Displays: The operator interface shall provide consistent text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.
- B. Graphic-based Displays: The operator interface shall provide MUI graphic based displays of each system and the existing graphics shall be modified to remove no longer applicable equipment and points. The point data associated with each system shall dynamically update at a minimum of every 30 seconds. Graphic displays shall be linked to each other to provide a “drill down” capability from main graphic displays to more specific system based displays. Provide a building level graphic display that links to system graphics. For systems that have ASC controlled terminal unit controls, provide a building floor plan with dynamic temperatures shown on the graphic that can be drilled into for more specific terminal information. Points provided in the graphic shall have the override and adjust capability specified under operator commands. The contractor providing the DDC system under this Section shall provide all graphic displays for the project.

PART 3 EXECUTION

4.01 GENERAL

- A. All electronic work required as an integral part of the Direct Digital Control system work is the responsibility of this section unless specifically indicated otherwise in this section, Section 23 09 54 - Electric Temperature Control Systems, or in Division 26.
- B. This contractor shall provide all labor, materials, engineering, software, permits, tools, checkout and certificates required to install a complete Direct Digital Control system as herein specified.
- C. Any and all points added with this project shall be grouped for display purposes into the system such that all points associated with a new or existing DDC system can appear together on the flat panel display or printed log. Assignment of points to a group shall not be restricted by hardware configuration of the points of direct digital control. It shall be possible to assign a point to appear in more than one system. An English descriptor and an alpha/numeric identifier shall identify each system.
- D. This Direct Digital Control system as herein specified shall be fully integrated and completely installed by this section. It shall include all required computer CPU software and hardware. Include the engineering, installation, supervision, calibration, software programming, and checkout necessary for a fully operational system.

4.02 INSTALLATION

- A. All work and materials are to conform in every detail to the rules and requirements of the National Electrical Code and present manufacturing standards. All wiring and cable installation shall conform with the wiring installation as specified in the installation section of Section 23 09 54 - Electric Temperature Control Systems. All material shall be UL approved.
- B. Install system and materials in accordance with manufacturer's instructions, rough-in drawings and details on drawings.
- C. Line voltage wiring to power the DDC Controllers, not provided by the Division 26 contractor, to be by this contractor. See plans for designations of location and quantity of Temperature Control Panels where power will be the responsibility of the Division 26 contractor. All others not shown shall be the responsibility of this contractor.
- D. Line voltage wiring to Temperature Control panels shall be served by permanent power – under no circumstances shall a control panel be served from receptacle power.
- E. Control panels serving equipment fed by emergency power shall also be served by emergency power.
- F. Provide uninterruptable power supplies where necessary to provide proper startup of equipment or to accomplish power restart control sequences specified.
- G. Mount control panels adjacent to associated equipment on vibration-free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
- H. Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.
- I. Cable tray routing of the communication trunks is acceptable.
- J. All tubing, cable and individual wiring is to be permanently tagged, with numbers corresponding with "Record Drawings", spares are to be labelled as "Spare".
- K. Provide technician to work with air balancing contractor and/or provide balancing contractor with necessary hardware to over-ride DDC controllers for air balancing.
- L. Provide documentation to demonstrate that all points, input and output, have been checked out and verified operational, note any points not operating properly with notation of reason.
- M. For VAV Application Specific Controllers, VAV to be directly coupled to the ASC controller and must have 90-degree stroke.

4.03 CONSTRUCTION VERIFICATION

- A. Contractor shall be responsible for DDC Point-to-Point checkout of DDC System to ensure all points are operable and accurate. Contractor must generate and provide signed and dated checkoff sheets as part of the Operations and Maintenance Manuals and project closeout, indicating all equipment has been tested and verified to be working correctly. Construction Verification shall apply to this section and Sections 23 09 15, 23 09 54, and 23 09 93.

4.04 FUNCTIONAL PERFORMANCE TESTING

- A. Contractor shall be responsible for sequence of operations checkout of DDC System and stand-alone systems to ensure systems operate according to sequence of operations. All programmed control loops and modes of operation shall be verified. Contractor must generate and provide signed and dated checkoff sheets as part of the Operations and Maintenance Manuals and project closeout, indicating all equipment has been tested and verified to be working correctly. Functional Performance Testing shall apply to this section and Sections 23 09 15, 23 09 54, and 23 09 93.

4.05 AGENCY TRAINING

- A. Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 16 hours. Coordinate with owner to break hours up into small segments and span over multiple sessions.
- B. Provide troubleshooting and instruction after substantial completion and the other at the end of the warranty period. Provide required information and complete troubleshooting and inspection activity for all controls installed under Sections 23 09 23, 23 09 54, and 23 09 93. Coordinate the visit with the owner/Agency and provide an inspection report to the owner of any deficiencies found.

END OF SECTION

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SECTION 23 09 34 - VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- B. Section 23 05 53 - Identification for HVAC Piping and Equipment: Identification products and requirements.
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
 - 2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
 - 3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include wiring diagrams showing factory and field connections.
- D. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- E. Project Record Documents: Record actual installed locations of controllers and final equipment settings.

1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company with minimum three years documented experience with variable-frequency motor control systems of similar size, type, and complexity; manufacturer's authorized installer.
- D. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB
- B. Eaton Corporation
- C. Danfoss
- D. Toshiba
- E. Yaskawa

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. For motors as indicated on the Variable Frequency Drive schedule on the drawings.
- D. Inverters shall be PM compatible where required for electronically commutated (EC) motors.

- E. Variable frequency systems to convert the unit fan motor and/or pump motor constant 60 hertz frequency to variable speed operation with the use of adjustable frequency inverters and the necessary hardware to provide the function as herein specified.
- F. Inverters are to be mounted in a NEMA 1 type enclosure. The following equipment and features are to be incorporated in each unit:
 - 1. Minimum and maximum speed adjustments. Minimum speed is to be adjustable to 1/3 of maximum speed.
 - 2. Adjustable linear acceleration and deceleration each separately adjustable effective during manual and automatic modes of operation.
 - 3. Rectifier/Converter: Diode-based, 12-pulse type (min.).
 - 4. Adjustable current limit.
 - 5. Dual thermal overloads.
 - 6. Inherent short circuit protection and ground fault protection.
 - 7. Automatic operation from a remote 4-20 ma input signal or a 0-10 volt signal.
 - 8. BACnet integration card.
 - 9. Under-voltage and over-voltage protection and single phase protection.
 - 10. Over-temperature protection.
 - 11. Rated to provide 110% of rated current for a minimum period of one minute.
 - 12. Five percent (5%) chokes on input line and DC bus choke which will prevent damaging spikes from the transformer or from power outages.
 - 13. Inverter is to be rated for an input power to +10% and -10%.
 - 14. Door interlocked circuit breaker or fused disconnect for drive and bypass.
 - 15. Multi line LCD display for operating status, programming and fault history.
- G. The following door mounted devices:
 - 1. Power "on" light.
 - 2. Digital readout for speed, load, and input KW, and faults.
 - 3. Manual/off/automatic selector switch.
 - 4. Manual speed potentiometer or keypad adjustment for operation in the manual-normal mode.
 - 5. Diagnostic readouts.
- H. Floor stand mounting kit for free standing installation if field conditions require.
- I. All components shall be pre-mounted and wired in a single enclosure. Each inverter and any associated hardware shall receive a minimum 20-40 minute "burn-in" high temperature test period under full load in conjunction with a certified statement which indicates that all components of the unit have been tested prior to assembly. A full 3 year warranty on all parts and labor must be provided.

- J. A field service engineer of the drive manufacturer is to be provided for a minimum of 2 hours for start-up assistance and training.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings of controllers are consistent with indicated requirements.
- C. Verify that mounting surfaces are ready to accept controllers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install in accordance with NEMA IS 10034 and manufacturer's instructions.
- C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions, NEC and NFPA 70.
- E. Provide required support and attachment in accordance with Section 23 05 29.
- F. Install controllers plumb and level.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Install field-installed devices, components, and accessories.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.03 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.04 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

- C. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.06 PROTECTION

- A. Protect installed controllers from subsequent construction operations.

END OF SECTION

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SECTION 23 09 54 - ELECTRIC TEMPERATURE CONTROL SYSTEMS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Section 23 05 93 – Testing, Adjusting, and Balancing
- C. Section 23 09 15 – DDC Points List
- D. Section 23 09 23 - Direct Digital Control Systems
- E. Section 23 09 93 – Automatic Controls Sequences
- F. Section 23 21 13 – Hydronic Systems – for well/tap installation
- G. Section 23 33 00 – Ductwork Accessories – for airflow measuring station or control damper installation

1.02 DESCRIPTION OF WORK

- A. The intent of this project is to provide automated temperature control and a Building Automation System for the building.
- B. Provide DDC for the following HVAC systems. See sequence of operations in 23 09 93 and DDC Points List in 23 09 15 for a more comprehensive description of DDC requirements
 - 1. Hot Water System
 - 2. Chilled Water and Condenser Water System
 - 3. Qty (5) Air Handling Units
 - 4. Exhaust and Ventilation Fans
 - 5. VAV Boxes
 - 6. Fan Coil Units
 - 7. Radiant Heat
 - 8. Unit Heaters
- C. Work in the section includes:
 - 1. Includes, but is not necessarily limited to, furnishing and installing a complete, calibrated, tested, adjusted and as intended, electric control system; including all thermostats, controllers, electric actuators, valves, switches, relays, transducers, sensors, transmitters, conduit, wiring and other equipment and accessories necessary to constitute a complete and coordinated automatic electric temperature control system, as described herein and shown on the drawings.
 - 2. Control and data wiring, except for power wiring, necessary for electric or electronic temperature control systems, is work of this section. Electrical work under this section shall be performed in accordance of Division 26 requirements.
 - 3. Automatic Control Dampers shall be furnished by this section and installed as a part of the Division 23 Work.

4. Thermowells (Temperature Sensing Wells), Automatic Control Valves, hydronic pressure sensors, and hydronic flow sensors/meters shall be furnished by this section and installed as a part of Division 23 Work.
 5. All control systems identified in Section 23 09 93 - Automatic Control Sequences is exclusively work of this section.
 6. Analog input signals and binary input signals shall be transmitted to the Direct Digital Control systems using electronic equipment, sensors, transmitters and transducer specified herein. The DDC system shall transmit binary and/or analog output signals to equipment to obtain specified control sequences.
 7. All controls installation, furnishing of devices, software, and programming, etc. shall be furnished, except where already included with packaged control systems. Graphics shall be provided for both directly controlled equipment and integrated equipment.
 8. Temperature Control Panels shown on the Mechanical Plans shall reuse the existing 120V power to the panel. This contractor shall be responsible for all other 120VAC power, not provided in the Division 26 specifications, required for equipment provided in this section.
- D. Work not included in this section:
1. Direct digital controls and energy management interface, as specified in Section 23 09 23.
 2. Refer to Division 26 sections for power wiring to line voltage devices.
 3. Access doors are not included under this section, but are included under Division 23.
 4. The installation of automatic control dampers, air flow stations, and air flow valves is part of the sheetmetal work of Division 23.
 5. The installation of thermowells, automatic control valves, wet-media sensors, flow meters, and wet-media transmitters is part of the piping work of Division 23.
- E. Reuse of existing controls infrastructure:
1. See 23 09 15 DDC Points List for a description on expectation of reusing or replacing controls devices.
 2. Temperature Control Panel enclosures are expected to be reused at their existing locations, reusing the 120V at the panel locations. Furnish new mounting backplates to house all new DDC and associated relays, power supplies, etc. and replace contents of existing control panel. Where enclosure size is insufficient for design needs, furnish additional temperature control panels as needed.
 3. Existing conduit containing HVAC controls wiring may be reused.
 4. Reuse of control wiring between the temperature control panel and the field device may be reused if deemed in good condition and meets specifications of Distech DDC and associated field components.
- F. Demolition of existing controls infrastructure:

1. Remove all existing DDC, power supplies, and associated controls components that are to be replaced as part of this project. Maintain integrity of existing DDC field communication trunk for continuation of service during phased approach to DDC replacement.
2. Metasys Network Automation Engines (NAE) shall be demo'd last, after all DDC has been converted to Distech. Turn NAEs over to owner.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code.
- B. ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
- C. ANSI/ASTM B32 Specification for Solder Metal
- D. ASTM B75 Seamless Copper Tube
- E. ASTM D1693 Environmental Stress-Cracking of Ethylene Plastics
- F. ASTM D 635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
- G. Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
- H. AMCA 500-D Laboratory Method of Testing Dampers for Rating

1.04 SUBMITTALS

- A. The following sections shall be submitted together as one package and shall be referenced on submittal cover page and paperwork.
 1. 23 09 15
 2. 23 09 54
 3. 23 09 93
- B. The following shall be included:
 1. Building Automation System Network Architecture Diagram indicating network layout of all communication buses including all hardware, operator workstation and software, and integrated devices. Where multiple field-level controllers are installed (e.g. VAV Box controller), references made to "typical of #" are acceptable.
 2. Manufacturer's data sheets indicating model number, pressure/temperature ratings, capacity, methods and materials of construction, installation instructions, and recommended maintenance. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked.

3. Schematic flow diagrams of systems showing fans, pumps, coils, dampers, valves, and other control devices. Each control device provided under this section shall be uniquely labeled. Duplicate labeling may be used within similar mechanical systems. Label each device with setting or adjustable range of control. Indicate all wiring, clearly, differentiating between factory and field installed wiring. Wiring should be shown in schematics that detail contact states, relay references, etc. Diagrammatic representations of devices alone are not acceptable.
4. Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Also include on drawings location of mechanical equipment controlled (room number), locations of all remote sensors and control devices (either by room number or column lines).
5. A list of all inputs and outputs associated with each controller.
6. Bill of Materials for all controls devices provided on the project, indicating part numbers, device manufacturer, and description of part.
7. Schedule of control dampers indicating size, leakage rating, arrangement, pressure drop at design airflow, and number and size of operators required.
8. Schedule of control valves indicating system in which the device is to be used, rated capacity, flow coefficient, flow required by device served, actual pressure drop at design flow, size of operator required, close-off pressure, and locations where valves are to be installed.
9. Sequence of operations for all DDC equipment.
10. All submittals are to comply with submission and content requirements specified in applicable provisions of Division 1.

1.05 QUALITY ASSURANCE

- A. Installer: Installing contractor must be a manufacturer's branch office or an authorized representative of a Direct Digital Control (DDC) equipment manufacturer that provides engineering and commissioning of the DDC equipment. DDC equipment may or may not be required to be installed by this contractor as part of the project, but the intent of this quality assurance specification is to ensure that the installing contractor has the capabilities to engineer, install, and commission the field devices supplied under this section for temperature control. Installer response time during the warrantee period shall be four (4) hours or less (24 hours/day, 7 days/week).
- B. Electrical Standards: Provide electrical products that have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.
- C. Provide control devices subject to corrosive environments with corrosion protection or construct them so they are suitable for use in such an environment.

- D. Provide devices exposed to outside ambient conditions with weather protection or construct them so they are suitable for outdoor installation.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory shipping cartons for each piece of equipment and control device. Provide factory applied plastic end caps on each length of pipe and tube. Maintain cartons and end caps through shipping, storage and handling as required to prevent equipment and pipe end damage and to eliminate dirt and moisture from equipment and inside of pipe and tube. Store equipment and materials inside and protected from weather.

1.07 OPERATION AND MAINTENANCE DATA

- A. The following sections shall be submitted together as one package for O&M Data: 23 09 15, 23 09 54, and 23 09 93. Specification sections shall be referenced on O&M submittal cover page and paperwork. Controls drawing package (as described below) shall clearly reference "As-built" or "Record Drawings" on title sheets with appropriate date. Simply submitting a copy of the original submittal with original submittal date in lieu of providing what is described herein is not acceptable and will be rejected. Include the following information:
 - 1. As-built Building Automation System Network Architecture Diagram indicating network layout of all communication buses including all hardware, operator workstation and software, and integrated devices.
 - 2. As-built communication bus routing of all connected devices. Each DDC controller shall be indicated and clearly shown which communication bus it resides on and the order of devices along the communication bus. Indicate where "End Of Line" is.
 - 3. Manufacturer's data sheets indicating model number, pressure/temperature ratings, capacity, methods and materials of construction, installation instructions, and recommended maintenance. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked.
 - 4. As-built list of all inputs and outputs associated with each controller.
 - 5. As-built Bill of Materials for all controls devices provided on the project, indicating part numbers, device manufacturer, and description of part.
 - 6. As-built schematic flow diagrams of systems showing fans, pumps, coils, dampers, valves, and other control devices. Each control device provided under this section shall be uniquely labeled. Duplicate labeling may be used within similar mechanical systems. Label each device with setting or adjustable range of control. Indicate all wiring, clearly, differentiating between factory and field installed wiring. Wiring should be shown in schematics that detail contact states, relay references, etc. Diagrammatic representations of devices alone are not acceptable.

7. As-built details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Also include on drawings location of mechanical equipment controlled (room number), locations of all remote sensors and control devices (either by room number or column lines).
8. As-built schedule of control dampers indicating size, leakage rating, arrangement, pressure drop at design airflow, and number and size of operators required.
9. As-built schedule of control valves indicating system in which the device is to be used, rated capacity, flow coefficient, flow required by device served, actual pressure drop at design flow, size of operator required, close-off pressure, and locations where valves are to be installed.
10. As-built sequence of operations for all DDC equipment, including final setpoints established with balancing contractor.
11. Completed Functional Performance Testing forms, as detailed in Section 23 08 00.

1.08 AGENCY TRAINING

- A. At project close-out, contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section.
- B. Unless otherwise directed by Agency DDC operations personnel, training provided by contractor shall include the following topics:
 1. OPERATOR INTERFACE TASKS, demonstrating how to:
 - a. Login/Logout
 - b. Define and modify schedules for equipment operation
 - c. View point data in lists and on graphics
 - d. View live trend data
 - e. View historical trend data
 - f. Acknowledge alarms
 - g. Adjust setpoints
 - h. Manually override logic and force actions, and release back to auto control
 - i. Edit time schedule parameters
 2. WALKING TOUR OF DDC SYSTEM:
 - a. Locations of all controlled HVAC systems (excluding terminal units unless in obscure location)
 - b. Locations of all Temperature Control Panels and designated function
 - c. Locations of any system sensors or controlled devices located outside of mechanical or electrical rooms (e.g. outdoor air temperature sensor, outdoor air static pressure reference, water differential pressure sensors, AHU supply static sensor, emergency HVAC shutdown switch)

3. TRAINING REFERENCE MATERIAL: At the time of owner training, provide a binder to the building operator containing the following information:
 - a. Simple step-by-step instructions, in a clear format, outlining the most commonly executed operator interface tasks as listed above. In lieu of printed material, contractor may provide instructional video demonstrating the tasks.
 - b. A copy of the DDC completed as-built drawings as defined above in "OPERATION AND MAINTENANCE DATA".
 - c. In each temperature control panel, provide a copy of the control drawings that pertain to equipment served by the temperature control panel. This should include a flow schematic of the system(s) served, the control panel and field wiring diagrams, and the sequence of operations.
 - d. Provide two follow-up visits for troubleshooting and instruction, one six months after substantial completion and the other at the end of the warranty period. Length of each visit to be not less than 4 hours or the time necessary to provide required information and complete troubleshooting and inspection activity for all controls installed. Coordinate the visit with the owner/Agency and provide an inspection report to the owner of any deficiencies found.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General:

1. Provide electric temperature control products in sizes and of capacities as required, conforming to manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer and as required for application indicated.
2. Provide control devices subject to corrosive environments with corrosion protection or construct them so they are suitable for use in such an environment.
3. Provide devices exposed to outside ambient conditions with weather protection or construct them so they are suitable for outdoor installation.
4. Use only UL labeled products that comply with NEMA Standards. Electrical components and installation to meet all requirements of the electrical sections (Division 26) of project specifications.
5. All valve and damper operators shall fail safe upon control power failure where indicated with a "NO" or "NC" on the HVAC controls schematics in the plans.

B. Control Valves:

1. Provide all control valves as shown on the plans/details and as required to perform functions specified.

2. Size operators to allow smooth and positive operation of devices served and to provide sufficient torque capacity for tight shutoff against system temperatures and pressure encountered.
3. For electric modulating actuation, use fully proportional actuators with 0-10VDC inputs unless specified otherwise in the chart below. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking. Electric actuators, for applications other than terminal units, shall be provided with a manual override capability. All electric actuators shall be provided with a visible position indicator.
4. Provide operators that are full proportioning or two-position, as required for specified sequence of operation. Provide spring-return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Valves shall move to their fail positions on loss of electrical power.
5. Two-position shut-off valves used for isolation of mechanical devices shall be sized for a maximum pressure drop of 2 PSI at design flow and shall be a minimum of line size.
6. Valve selections shall conform with the following table:

VALVE SERVING	TYPE Globe, Butterfly (BF), Ball, Press Independent Ball (PI Ball)	SIGNAL 0-10 VDC TriState (24VAC) 2-Position Elect	SPRING RETURN REQUIRED Yes No	FAIL POSITION Open (thru Coil) Closed (bypass Coil) Last Position
Reheat Coil	Globe or Ball	0-10 VDC	No	Last Position
Radiation w/ Reheat	Globe or Ball	0-10VDC, TriState, or 2-Pos	No	Last Position
Standalone Radiation	Globe or Ball	0-10 VDC or TriState	No	Last Position
CUH and UH	Globe or Ball	TriState or 2-Pos	Yes	Open
Fan Coil Heating	Globe or Ball	0-10 VDC	Yes	Open
Fan Coil Cooling	Globe or Ball	0-10 VDC	Yes	Closed
AHU Hot Water Heating Coil	Globe or Ball	0-10 VDC	Yes	Open
AHU Cooling Coil	Globe, Ball, or BF (BF only when 3" or	0-10 VDC	Yes	Closed

VALVE SERVING	TYPE Globe, Butterfly (BF), Ball, Press Independent Ball (PI Ball) greater)	SIGNAL 0-10 VDC TriState (24VAC) 2-Position Elect	SPRING RETURN REQUIRED Yes No	FAIL POSITION Open (thru Coil) Closed (bypass Coil) Last Position

C. Control Valves in Water Systems:

1. Use equal percentage valves for two-way control valves serving coils. Use linear valves for two-way control valves meant to satisfy flow conditions (e.g. chiller minimum flow valve, boiler minimum flow valve, chiller heat recovery flow valve). Consult with AE for acceptable pressure drop if available valve selections do not fall within the desired pressure range. Note: For low flows, the required minimum Cv size will result in lower pressure drop than 4 psi.
2. Use three-way valves sized for a maximum pressure drop of 5 psi and that have linear characteristics so that the valve pressure drop remains constant regardless of the valve position.
3. Globe valves 2" and smaller: Cast bronze or forged brass body, brass plug and brass or stainless steel seat, stainless steel stem, screwed ends, suitable for use on water systems at 150 psig and 240° F. Seat leakage with actuator supplied will meet ANSI class IV leakage (0.01%). For globe valves that are specified to fail in place, valves shall be open when the stem is up. Only the following globe valve body styles will be acceptable for terminal unit control: Siemens Powermite 599 VF Series (599 VE Series Zone Valves are not acceptable), Invensys VB7200 Series, Johnson Controls VG7000 Series, and Honeywell V5011/V5013 Series. Minimum size for globe valves shall be 1.5 Cv. No minimum size for CCV ball valves.
4. Globe valves 2 1/2" and larger: Iron body, brass plug and seat, stainless steel stem, spring loaded Teflon, or EPDM packing, flanged ends, suitable for use on water systems at 150 psig and 240° F.
5. Butterfly valves: Iron body, stainless steel shaft, bronze bearings, and resilient seat. Disc to be aluminum-bronze, nickel-plated ductile iron, cast iron with welded nickel edge, Nylon 11 coated, or stainless steel. Valve assembly to be bubble tight, suitable for use on water systems at 150 psig and 240° F. For pneumatically actuated valves, provide pilot positioners on all operators for butterfly valves used in modulating applications. When butterfly valves are used in modulating applications, entering and leaving pipe sizes and required transition distances shall be detailed on the control valve submittals. The control contractor shall be responsible for coordinating the proper pipe sizes and transitions with the mechanical contractor to provide the correct Cv at 70° open position.

6. Characterized Ball Valves: The following manufacturers are acceptable: Honeywell, Belimo, Johnson Controls, KMC Controls, Yamatake, Bray. For use on terminal units only where specified above. Forged brass or bronze body, stainless steel shaft and ball, reinforced Teflon or PTFE ball seals, double O-ring stem seals, characterized disk, maximum of ANSI Class IV (0.01%) leakage, suitable for use on water systems at 150 psig and 212° F. Note: Only ball valves with a characterized disc shall be acceptable.

D. Control Dampers:

1. Provide control dampers shown on the plans and as required to perform the specified functions. Dampers shall be rated for velocities that will be encountered at maximum system design and rated for pressure equal or greater than the ductwork pressure class as specified in [Section 23 31 00] of the ductwork where the damper is installed.
2. Use only factory fabricated dampers with mechanically captured replaceable resilient blade seals, stainless steel jamb seals and with entire assembly suitable for the maximum temperature and air velocities encountered in the system.
3. All dampers in stainless steel, PCD coated steel, PVC, PTFE, or fiberglass ductwork shall be constructed of stainless steel.
4. All dampers in aluminum ductwork shall be constructed of stainless steel or aluminum.
5. Dampers in galvanized ductwork shall be constructed of galvanized steel and/or aluminum.
6. All dampers, unless otherwise specified, to be rated at a minimum of 180° F working temperature. Leakage testing shall be certified to be based on latest edition of AMCA Standard 500-D and all dampers, unless otherwise specified, shall have leakage ratings as follows:

Class IA	1" w.g.	=/<3 CFM/ft2	Damper Class	Differential Pressure	Leakage
Class I	4" w.g.	=/<8 CFM/ft2			
Class I	8" w.g.	=/<11 CFM/ft2			
Class I	12" w.g.	=/<14 CFM/ft2			

7. Leakage rate dampers for differential pressures that they will encounter at maximum system design pressures.
8. Steel framed dampers: Nailor models 2010 & 2020; Greenheck models VCD-33 & VCD-42; Johnson Controls model V-1330; Ruskin Models CD60 & CD40; other approved equal.
9. Aluminum frame and blade dampers: Nailor models 2010EAF & 202EAF; Greenheck model VCD-43; Ruskin model CD50; Arrow model AFD-20; other approved equal.

10. Dampers used for directed mixing of airstreams, i.e. outside air and return air, to be parallel blade type and sized for an air velocity of 1800 to 2000 fpm with the damper blades shall be arranged so that the air streams are directed at one another to facilitate mixing. Dampers used for throttling or modulating applications other than air stream mixing to be opposed blade type. Two position dampers may be parallel or opposed blade type.
 11. Dampers used for isolation on the discharge of centrifugal fans shall have damper blades perpendicular to the fan shaft to minimize system effect. Dampers mounted with blades vertically shall be designed for vertical blade orientation.
 12. Dampers for applications other than fume exhaust to have frames of not less than 16 gauge galvanized steel or 12 gauge extruded aluminum. Blades to be two-ply steel airfoil of not less than 2 x 20 gauge galvanized steel (14 gauge equivalent) or extruded aluminum airfoil, with stainless steel, acetal, Celcon, bronze, or nylon bearings. Maximum allowable blade width is 8 inches. Use plated steel linkage hardware.
 13. Maximum damper width is 48 inches; where required width exceeds 48 inches, use multiple damper sections. Inside frame free area shall be a minimum of 90% of total inside duct area.
 14. Multiple width damper sections shall utilize jack shaft linkages unless noted below.
Sections over 144 inches wide shall be actuated from two locations on the jack shaft.
Double width damper sections for two-position operation may be actuated without jack shafts if each damper section is actuated separately. Dampers that have multiple width and multiple vertical sections shall have a jackshaft for each vertically stacked set of dampers and be provided with crossover linkages between jack shafts to transfer uneven loading.
 15. Jack shafts shall be extended outside of the ductwork for external actuator mounting. Provide bearings on the point of exit for support of damper shafts to prevent wear on the shaft and the ductwork. If locating actuators out of the air stream is impossible, obtain mounting location approval from the designer unless the contract documents indicate in air stream mounting is acceptable. In no cases shall damper actuators for fume exhaust systems be located in the air stream or require entering the air stream to service an actuator.
- E. Electric Operators:
1. Provide weatherproof NEMA 4 enclosures that have removable covers that have clasps or machine screws (no sheet metal screws) and that do not require removing fasteners from the ductwork to prevent actuator failure or freeze-up when mounting in locations exposed to harsh environments or outdoor locations.

2. Size operators for smooth and positive operation of devices served, and with sufficient torque capacity to provide tight shutoff against system temperatures and pressure encountered. For electric modulating actuation, use fully proportional actuators with zero and span adjustments. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking.
 3. Actuator stroke times shall match the requirements of the DDC controllers provided under 23 09 23 and/or the specific system requirements for proper operation. All electric actuators will be provided with overload protection to prevent motor from damage when stall condition is encountered. Equip operators with spring return or stored energy fail-safe return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Face and bypass dampers for heating applications shall fail to the face position.
 4. Provide independently mounted damper end switches (Kele TS-475, Ruskin SP-101/105, or equal) with form "C" contacts where control sequences require damper position indication or interlock. Damper end switches shall be independent of the damper actuators and be mounted directly to the damper shaft or auxiliary shaft that is mounted to a drive blade of the damper. End switches shall not contain mercury.
 5. All power required for electric actuation shall be provided by this contractor if it is not able to be directly provided from the DDC controller.
 6. Provide operators with linkages and brackets for mounting on device served.
- F. Electric/Electronic Thermostats (Stand-alone operation where points not specified in 23 09 15):
1. Electric Thermostats:
 - a. For single setpoint applications, provide line or low voltage electric type suitable for heating or heating and cooling as required.
 2. Low Voltage Electronic Thermostats:
 - a. Where unoccupied setpoints are specified, provide electronic programmable type with seven-day setup/setback scheduling with setpoints and occupancy times as indicated in 23 09 93. For heating and cooling applications, provide automatic heating/cooling switchover. For applications that control fans, provide fan override switch. For ventilation or packaged economizer applications provide a dry contact for ventilation damper or economizer initiation. For thermostat control of economizer, provide a 0-10VDC modulated output for economizer damper control.
 - b. For applications that require integration to the building automation system, provide a BACnet communication interface. If a communication interface is specified, occupancy scheduling in the thermostat is not required.
 3. Low Limit Thermostats (Freezestats):

- a. Electric two-position type with temperature sensing element and manual reset for all applications. Unit to be capable of opening control circuit if any one-foot length of sensing element is subject to a temperature below the setpoint. Length of sensing element to be not less than one lineal foot per square foot of coil surface areas.
Unless otherwise indicated, set low limit controls at 36°F.
- 4. Aquastats:
 - a. Line voltage type with single pole, double throw switch of adequate rating for the applied load.
- G. Electronic Temperature Sensors/Transmitters:
 - 1. Thermistor temperature sensor manufacturers: PreCon, BAPI, Veris, JCI, and ACI
 - 2. Use thermistor or RTD type temperature sensing elements constructed so accuracy and life expectancy is not affected by moisture, physical vibration, or other conditions that exist in each application. RTD's shall be of nickel or platinum construction and have a base resistance of 1000 ohm at 70°F and 32°F respectively. 100 ohm platinum RTD's are acceptable if used with temperature transmitters.
 - 3. The temperature sensing device used must be compatible with the DDC controllers used on the project.
 - a. RTD
 - 1) Accuracy (Room Sensor Only): minimum + 1.0°F
 - 2) Accuracy (Averaging): minimum + 1.2°F
 - 3) Accuracy (Other than Room Sensor or Averaging): minimum + 0.65°F
 - 4) Range: minimum -40 - 220°F
 - b. Thermistor
 - 1) Accuracy (All): minimum + 0.36°F
 - 2) Range: minimum -30 - 230°F
 - 3) Heat Dissipation Constant : minimum 2.7 mW/°C
 - c. Temperature Transmitter
 - 1) Accuracy: minimum + 0.1°F or +0.2% of span
 - 2) Output: 4-20 mA
 - 4. Provide limited range or extended range sensors if required to sense the range expected for a respective point. Use RTD type sensors for extended ranges beyond -30 to 230°F. If RTD's are incompatible with DDC controller direct temperature input use temperature transmitters in conjunction with RTD's.

5. Use wire size appropriate to limit temperature offset due to wire resistance to 1.0°F. If offset is greater than 1.0°F due to wire resistance, use temperature transmitter. If feature is available in DDC controller, compensate for wire resistance in software input definition.
 6. Zone temperature sensors shall be provided with digital displays that indicate room temperature and setpoint and have a manual occupancy override where indicated in 23 09 15 DDC Points List. Provide setpoint adjustment as specified in the DDC Input/Output Summary Table and sequence of operation.
 7. Use averaging elements on duct sensors when the ductwork is ten square feet or larger. All mixed air and heating coil discharge sensors shall have averaging elements regardless of duct size.
 8. In piping systems use temperature sensors with separable wells designed to be used with temperature element.
- H. Humidity Sensors:
1. Use capacitive thin-film polymer sensor types with a range of 0-100% RH. Accuracy to be no less than $\pm 2\%$ in the range of 20% RH to 80% RH with a response time of 120 seconds or less. Provide covers for room humidity sensors as specified for temperature sensors.
 2. For outside air applications, use sensor designed for outside air use along with weather enclosure. Provide sensor equal to Vaisala Model HMD60UO w/ DTR503B enclosure and weather resistant mounting hardware.
- I. Pressure Transducers (Air):
1. Provide pressure transducers specified below for the following applications:
 - a. Duct static pressure applications where setpoints are specified to control at greater than 0.1" w.c.
 - b. Pitot type fan inlet air flow stations.
 2. Manufacturers: Mamac Systems, Setra, and Veris Industries.
 3. Provide a transmitter that operates on the capacitance principle and is capable of sensing low positive, negative or differential pressures. Transmitter shall have a minimum of three pressure ranges adjustable by an onboard switch or jumper. Size the transmitter where the middle or high range is suitable for the application. Use a bi-directional transmitter for applications that may have both positive and negative pressure excursions. Transmitter shall be provided with an integral four-digit display of the pressure sensed.
 - a. Accuracy (including non-linearity and hysteresis): + 1% FS
 - b. Compensated Temperature Range: 32°-140° F
 - c. Temperature Effect: 0-1"wc Range .09% FS/°F; >1"wc Range .02% FS/°F
 - d. Output: 4-20 MA
 - e. Load Impedance (smallest maximum acceptable): 800 ohm max.

- f. Operating Temperature: 32°-140° F
 - 4. Provide pressure transducers specified below for the following applications:
 - a. Duct static pressure applications where setpoints are specified to control at 0.1" w.c. or lower.
 - b. All duct mounted pitot type air flow stations.
 - c. Space/building static control or monitoring.
 - 5. Manufacturers: Setra 267, Paragon Controls MicroTrans, Air Monitor Veltron DPT2500 Plus, or approved equal. The airflow transducer shall provide zero and span adjustment for calibration. Use a bi-directional transmitter for applications that may have both positive and negative pressure excursions. Transmitter shall be provided with an integral four-digit display of the pressure sensed.
 - a. Transducer Span: <2 times the design velocity pressure at maximum flow, single range
 - b. Accuracy: +/-0.25% of full scale, including non-linearity, hysteresis, deadband, and non-repeatability
 - c. Temperature Effect: +/-0.15% of full scale/°F
 - d. Response: 0.5 sec. for 98% of full span change
 - e. Overpressure: 5 PSIG Proof
 - f. Power: 24VAC/VDC
 - g. Analog Output: 0-5VDC, 0-10VDC, or 4-20mA field adjustable
 - 6. For space or building static pressure monitoring, use Vaisala model SPH10 Static Pressure Head, or approved equal for outside air reference. Mount in location above roofline away from any air exchanges.
- J. Pressure Transducers (Liquid/Steam):
- 1. Differential Pressure Transducers utilized for measuring flow across each chiller shall have an accuracy of +/-0.2%. All other criteria shall be met as detailed below.
 - 2. Provide a transmitter that utilizes capacitive or thin film strain gauge sensing. Provide for an analog gauge piped in parallel with the transducer. Gauge shall meet specifications as specified in Section 23 05 15. Coordinate with mechanical contractor to provide and install this gauge. For differential pressure applications provide with bypass valve manifold assembly with valved venting capability.
 - a. Accuracy (including non-linearity and hysteresis): + 0.5% FS
 - b. Compensated Temperature Range: 32°-150° F
 - c. Temperature Effect (over compensated range): 0.03%/°F;
 - d. Output: 4-20 MA
 - e. Load Impedance (smallest maximum acceptable): 600 ohm Minimum
 - f. Operating Temperature: 0°-175° F

g. Hysteresis: 0.75% of span

K. Differential Pressure Switches:

1. Differential pressure switches shall sense both inlet and outlet of pressure across a component. Device shall be rated for 150% of maximum system pressures that may be encountered. Provide with pressure differential that will be required to meet specified operation and/or to prevent nuisance "toggling" of the device in the system served.

L. Air Pressure Safety Switches:

1. Air pressure safety switches shall be a differential pressure switch that will sense differential, negative, or positive pressure as required by the sequence of operation specification. Device shall be rated for a minimum of 150% of maximum system pressures that may be encountered. Provide with pressure range that will be required to meet specified operation in the system served. Provide with a normally closed contact that will open above setpoint and will not close until the manual reset button is depressed. Setpoint shall be manually adjustable.

M. Current Status Switches:

1. Provide a current sensor with adjustable threshold and digital output with LED display, equal to a Veris model H-708/H-904. Threshold adjustment must be by a multi-turn potentiometer or set by multiprocessor that will automatically compensate for frequency and amperage changes associated with variable frequency drives. When used on variable speed motor applications, use a current sensor that will not change state due to varying speeds.

N. Carbon Dioxide (CO2) Sensor:

1. For rooms where a CO2 sensor and temperature sensor are both required, provide a combination device such that one wall sensor measures both temperature and CO2.
2. Provide a Carbon Dioxide (CO2) sensor that shall utilize non-dispersive infrared (NDIR) technology. The sensor shall have a linear analog output over a range of 0-2000 ppm and have built in display of CO2 level. The sensor shall have an automatic calibration algorithm that will compensate for sensor drift over time due to sensor element degradation. Unit shall be provided with a 0-10VDC or 4-20mA analog output that is selectable and a field adjustable relay alarm output. Accuracy shall be better than $\pm 5\%$ of reading or ± 50 ppm whichever is higher.
3. The sensor shall be user calibratable with a minimum calibration interval of five years.

O. Airflow Measuring Stations:

1. Provide airflow measuring stations (AMS) for ducts, fan inlets, and outside air as required on plans.
2. Acceptable Manufacturers: Accutrol IAQ-TEK for outside airflow measurement, where scheduled.

3. Substitution Requirements:
 - a. For any product to be considered for substitution, a written document shall be submitted to the engineer detailing exceptions and compliance, section-by-section with supporting documentation, before an approval will be considered
 - b. Any product submitted as an equal shall be expected to comply with all performance capabilities and functional aspects of this specification.
4. Excluded Devices:
 - a. Measurement technologies such as Thermal Dispersion type using multipoint “bead-in-glass” thermistors are not acceptable.
 - b. Measurement technologies such as Thermal Dispersion type using “chip-in-glass”, “chip-in-epoxy” or “chip” type thermistors for the heated sensor component are not acceptable.
 - c. Transmitter and probe assemblies that state factory recalibration is required to maintain accuracy are not acceptable.
 - d. Airflow sensors that are affected by dust, humidity and altitude are not acceptable.
5. Airflow measuring stations for ducts:
 - a. General
 - 1) Provide AMS location as shown on the plans, schedules and/or control diagrams to determine the average airflow rate for monitoring and/or control.
 - 2) Each VorTek AMS shall be provided with a microprocessor-based transmitter and one or more sensors.
 - 3) Airflow measurement device shall be field configurable and adjustable to determine the average airflow rates.
 - b. Transmitter:
 - 1) The transmitter shall be capable of utilizing a remote display when the location of the transmitter is not accessible, connected with factory assembled cables that are available in lengths of 25', 50', 75' and 100' as required for remote digital readout locations.
 - 2) The measurement input shall be digital and will not require an Analog-to-Digital convertor. The transmitter shall provide a scalable analog output, which is field configurable using a free intuitive graphical user interface. The output signal of the transmitter shall be 0-10VDC. Power requirement for the transmitter shall be 24VAC or DC.
 - 3) Measurement system accuracy shall be +/- 3% of volumetric airflow rate with recommended sensor density, installation distribution and proper upstream requirements. Individual sensor accuracy shall be +/- 2% of reading to NIST-traceable standards. Measurement system accuracy of duct airflow measurement shall be +/-3% of volumetric airflow rate; +/-5% of reading for fan inlet and fan array systems.

- 4) Configuration parameters and adjustments shall be accessible via a free Graphical User interface (GUI) PC application that connects to the transmitter locally, or through the remote display via a standard USB Mini B port. This GUI application shall be available to the technician or the balancer via a free download, thereby reducing start-up and commissioning time without dependence on factory trained personnel to be onsite for this work. Menu driven interfaces using push button and simple alpha numeric display are not acceptable.
 - 5) The transmitter shall have the ability through the GUI, to provide a simple calculator for the balancer's field adjustment.
 - 6) The transmitter shall be CE Marked and RoHS compliant.
- c. IAQ-TEK for Outdoor Air:
- 1) General:
 - a) Provide IAQ-TEK measurement location as shown on the plans, schedules and/or control diagrams to determine the average airflow rate for monitoring and/or control of Outside Air.
 - b) Each IAQ-TEK shall be provided with a microprocessor-based transmitter and one or more sensor probes.
 - c) Airflow measurement shall be field configurable and adjustable to determine the average airflow rates.
 - d) Each IAQ-TEK measurement location shall be comprised of a set of probes to properly sample the air intake.
 - 2) Velocity Sensing Probes:
 - a) Velocity Range: Probe shall operate over the range of 1000 to 75 fpm with a 0.100"wc transmitter, higher range transmitters shall be available for greater velocities. Turndown in any specific application shall be a minimum of eight to one.
 - b) Quantity: Probes are to be provided in the quantity recommended by the manufacturer for the specific area to be monitored.
 - c) Mounting: Probes shall be provided with any special hardware required to assure secure mounting. Mounting hardware shall be 304SS. Galvanized or aluminum hardware shall be unacceptable. Probe shall be mounted to minimize extreme angular velocities. Installer to follow manufacturer's mounting instructions.
 - d) Orientation: Probe must be located facing into air stream and isolated from return airflow. Pressure connection barbs must be upright.

- e) Cleaning: Probes shall be able to withstand periodic wash-down with water without a degradation in signal quality. If probes cannot be cleaned in this manner, provide upstream filter assemblies to protect the probes from dirt. Filters shall be provided upstream due to contaminants in outside air.
 - f) Humidity: Sensor shall not be affected by high levels of water vapor, including entrained rain and fog. Thermal devices shall not be acceptable due to condensation affecting the operation of the unit.
- 3) Transducer:
- a) Style: Differential pressure type, high accuracy, complete with auto-zero valve and ambient temperature sensor.
 - b) Range: Differential pressure range shall be selected for the corresponding air velocity range being measured.
 - c) Temperature range: Transducer shall be capable of operating over the range of -30 to 120 degrees F without any temperature induced errors including zero or span shift.
 - d) Environment: Transducer shall be mounted in a sealed NEMA 4 enclosure, suitable for mounting in the outdoor air plenum.
 - e) Pressure Connections: 1/4 inch barbed connections shall be provided for high and low pressure sensing.
 - f) Electrical Connections: A weather tight connection cable with weatherproof Amphenol type connector shall be provided. Cable shall be plenum rated.
 - g) Humidity: Transducer shall be protected from condensation in sensing chamber and connection tubing when transducer temperature is lower than the dew point of the measured air stream.
- 4) Monitor Electronics:
- a) Style: Microprocessor based electronics including integral display and operator keypad.
 - b) Function: Receive signals from transducer and probes, calculate outdoor air volume and temperature, display information to user, transmit information to building automation system, perform self-diagnostics, and alarm on low outdoor air volume.
 - c) Display: A 4-line by 20-character alpha-numeric LCD operator's display shall be provided and shall be backlit for use in low light areas.
 - d) Temperature range: Monitor shall be capable of operating over the range of +30 to 110 degrees F.

- e) Environment: Monitor shall be mounted in a sealed NEMA 4 enclosure, suitable for mounting outdoors if required. Enclosure shall include clear window to allow viewing of monitor display without opening the door.
- f) Calculations: Monitor shall perform calculations including: differential pressure to velocity and velocity to volume conversions; and, correct for altitude, intake air temperature, transducer zero drift and span shift.
- g) Analog Outputs: Monitor shall provide industry standard 4-20mA outputs for corrected volume and outdoor air temperature. Scaling of volume output shall be adjustable by the user. Diagnostic functions shall be provided to assist in troubleshooting connections.
- h) Contact Outputs: A SPDT contact shall be available which will be normally energized and shall indicate either an alarm condition or unit problem.
- i) Setup Wizards: The monitor shall include preprogrammed setup wizards to lead the building automation contractor, test and balance contractor, and/or user through the steps necessary to commission the system.

P. Temperature Control Panels:

- 1. Constructed of steel or extruded aluminum, with hinged door, keyed lock, and baked enamel finish. Install controls, relays, transducers and automatic switches inside panels. Label devices with permanent printed labels and provide asbuilt wiring/piping diagram within enclosure. Provide raceways for wiring and poly within panel for neat appearance. Provide termination blocks for all wiring terminations. Label outside of panel with panel number corresponding to plan tags and asbuilt control drawings as well as building system(s) served.
- 2. Control panels that have devices or terminations that are fed or switch 50V or higher shall enclose the devices, terminations, and wiring so that Personal Protective Equipment (PPE) is not required to service the under 50V devices and terminations within the control panel. As an alternative, a separate panel for only the 50V and higher devices may be provided and mounted adjacent to the under 50V control panel.
- 3. Provide a disconnect switch inside the temperature control panel that interrupts power to all powered devices inside the panel as well as field devices powered from the panel.

Q. Power Supplies:

- 1. Provide all required power supplies for actuators, transducers, sensors, transmitters and relays. All low voltage transformers shall have a resettable secondary circuit breaker and be listed as class 2 power supplies.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install system with trained mechanics and electricians employed by the control equipment manufacturer or an authorized representative of the manufacturer. Where installing contractor is an authorized representative of the control manufacturer, such authorization shall have been in effect for a period of no less than three years.
- B. Install all control equipment, accessories, wiring, and piping in a neat and workmanlike manner. All control devices must be installed in accessible locations. This contractor shall verify that all control devices furnished under this Section are functional and operating the mechanical equipment as specified in Section 23 09 93.
- C. Label all control devices with the exception of terminal unit devices with permanent printed labels that correspond to control drawings. Labeling for each device shall be unique within each mechanical system.
- D. All control devices and electrical boxes mounted on insulated ductwork shall be mounted over the insulation. Provide mounting stand-offs where necessary for adequate support. Cutting and removal of insulation to mount devices directly on ductwork is not acceptable. This contractor shall coordinate with the insulation contractor to provide for continuous insulation of ductwork.
- E. Mounting of electrical or electronic devices shall be protected from weather if the building is not completely enclosed. This Contractor shall be solely responsible for replacing any equipment that is damaged by water that infiltrates the building if equipment is installed prior to the building being enclosed.
- F. Provide all electrical relays and wiring, line and low voltage, for control systems, devices and components. Install all high voltage and low voltage wiring (includes low voltage cable) in Electrical Metallic Tubing (EMT) except above accessible ceilings. All raceways, enclosures, fittings and associated supports shall be provided and installed according to the requirements set forth in Division 26, NFPA 90 (NEC), Chapter SPS 316 of the Wisconsin Administrative Code. All conduits shall be routed parallel and/or perpendicular to walls and adjacent piping. Raceways shall be located to maintain headroom and working clearance around equipment and devices that require inspection and service. All cable routed to devices within spaces with exposed finished structure shall be installed in EMT raceway routed to the nearest accessible ceiling cavity and the raceway, junction box, supports, fittings, backbox, junction box cover plates, etc. shall be painted to match the architectural finish color.

- G. In general, support all raceways from the building structure. No component of a raceway system shall be secured to corrugated metal roof deck. Do not impose on the installations of other trades. Securing conduit, rods, straps, hangers, etc. to suspended ceiling components, electrical raceways, plumbing piping, fire protection sprinkler piping, HVAC piping or ductwork, or their associated support systems, will not be accepted.
- H. Conduit shall be a minimum of 1/2 " for low voltage control provided the pipe fill does not exceed 40%.
- I. Where HVAC equipment control panels, or devices, do not provide for the direct connection of conduits, exposed wiring may be extended to complete the final connections, providing it does not exceed 18 inches in length.
- J. Minimum low voltage wiring gauge to be 18 AWG for outputs and 20 AWG for inputs. All low voltage wiring to be stranded. IP Cable shall be CAT6.
- K. Low voltage wiring and data cabling can be run without conduit above accessible lay-in tile ceilings. All wiring and data cabling in mechanical rooms, above inaccessible hard ceilings, exterior locations, and in any exposed areas, and in all other locations shall be in conduit. Wire for wall sensors shall be run in conduit. Wiring for radiation valves shall be run in conduit where routed through walls. Existing raceways for sensors shall be reused to limit exposed conduit on walls.
- L. Where wiring/cabling is installed free-air, installation shall comply with the following:
 - 1. Wiring shall utilize the cable tray wherever possible.
 - 2. Wiring shall run at right angles and be kept clear of other trades work.
 - 3. Wiring shall be supported utilizing "J" or "Bridal-type" steel mounting rings anchored to ceiling concrete, piping supports, walls above ceiling or structural steel beams. Mounting rings shall be of open design (not a closed loop) to allow additional wire to be strung without being threaded through the ring. For mounting rings that do not completely surround the wire, attach the wire to the mounting ring with a strap.
 - 4. At HVAC terminal units only, where the wiring serves a specific device; e.g. controller, actuator, transmitter, etc. associated with the unit, the j-hooks or Bridal rings required to support the wiring, may be secured to the rods or straps that support the ductwork or piping that serves the unit. Wall penetrations shall be sleeved.
 - 5. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If wiring "sag" at mid-span exceeds 6-inches; another support shall be used.
 - 6. Wall penetrations shall be sleeved and fire stopped as specified.
 - 7. Wiring shall not be supported from existing cabling, existing tubing, plumbing or steam piping, ductwork, any component of a suspended ceiling, or electrical or communications conduit.
- M. IP Communication Cabling:

1. CAT6
 2. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 3. Do not over-cinch or crush cables.
 4. Do not exceed manufacturer's recommended cable pull tension.
 5. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
 6. Manufacturer approved conduit bushings MUST be in place on every conduit opening that cable will be installed in prior to running the cable. Confirm before cable installation.
- N. Line voltage wiring to control panels shall be served by permanent power – under no circumstances shall a control panel be served from receptacle power.
- O. All wiring in control panels shall be terminated on a terminal strip. Wire nuts are not acceptable. A maximum of two wires shall be terminated under any one terminal.
- P. All pneumatic tubing and electrical wiring are to be permanently tagged or labeled within one inch of terminal strip with a numbering system to correspond with the asbuilt drawing package.
- Q. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

3.02 AIR PIPING

- A. Mechanically attach tubing to supporting surfaces. Sleeve through concrete surfaces in minimum one-inch sleeves, extended 6 inches above floors and one inch below bottom surface of slabs. Fire stop any open space in the sleeve after the air piping is installed if the sleeve is in a fire rated surface.
- B. Install all polyethylene tubing in conduit as scheduled below unless specified otherwise hereafter. Exposed polyethylene tubing not exceeding 18 inches may be used for connection to an instrument or operator without being installed in conduit. All Conduit to be independently supported, all boxes must be supported, all conduit ends to have bushings for protection of tubing.
- C. Conduit shall be a minimum of 1/2 " for poly tubing provided the pipe fill does not exceed 40%.
- D. Minimum poly tubing size allowed is 1/4" OD. If an instrument has a barbed fitting that will only accept 5/32" tubing, connection to the device can be made with 5/32" tubing that is as short as is practical. Couplings are acceptable in this instance.
- E. Install all exposed piping and conduit parallel to or at right angles to the building structure and support adequately at uniform intervals. Use only tool made bends in copper air pipe.
- F. Where polyethylene tubing is installed free-air, installation shall consider the following:
1. Tubing shall run at right angles and be kept clear of other trades work.

2. Tubing shall be supported utilizing "J-" or "Bridal-type" mounting rings anchored to ceiling concrete, piping supports or structural steel beams. Rings shall be designed to maintain tubing bend to larger than the minimum bend radius (typically 4 x tubing diameter).
 3. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If tubing "sag" at mid-span exceeds 6-inches, another support shall be used.
 4. Tubing shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
- G. Tubing shall not be attached to existing cabling, existing tubing, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.
- H. Tubing connected to air terminal unit devices shall be attached to the terminal unit device to prevent tubing from becoming kinked or becoming disconnected. Tubing serving air terminals may be routed on top of ductwork serving that terminal unit for a maximum distance of eight feet.
- I. Tubing directly connected to steam valve actuators shall be copper tubing for a minimum of six inches.
- J. Where tubing is connected to ductwork at an exterior location for sensing purposes, the tubing shall be sloped to a heated interior location without sags or traps in the tubing to prevent condensation to be trapped in the tubing and prevent accurate sensing. Install drip leg at low point at interior location and note location on control record drawings.
- K. Number code all polyethylene tubing and install neatly with no concealed splices.
- L. Piping material used shall be as follows:
1. Polyethylene tubing in block, stud. or concrete walls must be in conduit and associated boxes to be of steel.
 2. Where air piping is within concrete slab or under grade use only polyethylene tubing in conduit
 3. For exposed outdoor locations, use hard copper or polyethylene tubing in conduit. Provide shielding for polyethylene tubing that is used for final device connection that will be exposed to direct sunlight.
 4. For static sensing lines connected to ductwork located in exposed outdoor locations, slope piping from connection into building to a location that will be above freezing so any condensation will run into the building and not freeze in piping. Piping tap shall not be on the bottom of the ductwork. Provide a drip leg of 3/8" tubing a minimum of one foot in length in an accessible location inside the building that will collect condensation from the sensing line.
 5. Polyethylene tubing may be used in exposed areas if run in a fully enclosed rigid metal raceway or metal conduit and ambient temperature is less than 150°F.

6. Use copper tubing, where subject to temperatures in excess of 150°F or where adjacent to heating pipes passing through a common sleeve.
7. When polyethylene tubing is used above accessible lay-in acoustical panel ceilings it must be fire resistance "FR" rated pass the UL 94 vertical flame test with a rating of V2, be rated as self-extinguishing under ASTM D 635, and may be run without conduit.

3.03 WIRE AND AIR PIPING CONDUIT AND TUBING INSTALLATION SCHEDULE

- A. The following conduit schedule shall apply to both polyethylene tubing and wire in conduit where conduit is specified for air tubing or wiring. Conduit and tubing referenced below shall meet specifications in Division 26 and as defined below.
 1. Conduit other than that specified below for specific applications shall not be used.
 2. Underground Installations within Five Feet (1.5 m) of Foundation Wall: Rigid steel conduit.
 3. Underground Installations More than Five Feet (1.5 m) From Foundation Wall: Rigid steel conduit. Plastic-coated rigid steel conduit. Schedule 40 PVC conduit.
 4. Under Slab on Grade Installations: Schedule 40 PVC conduit.
 5. Exposed Outdoor Locations: Rigid steel conduit.
 6. Concealed in Concrete and Block Walls: Rigid steel conduit. Schedule 40 PVC conduit. Electrical Nonmetallic Tubing (ENT).
 7. Wet Interior Locations: Rigid steel conduit.
 8. Concealed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.
 9. Exposed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.

3.04 CONTROL DAMPERS

- A. All control dampers furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.
- B. Damper end switches, where required, shall be independently mounted to the damper drive shaft or auxiliary shaft attached to a damper drive blade. End switches shall be adjusted to prove the damper the position opposite the fail position of the damper actuator unless the control sequence requires a different position to be proven to accomplish the specified control sequence.
- C. Coordinate installation with the sheetmetal installer to obtain smooth duct transitions where damper size is different than duct size. Blank off plates will not be accepted.
- D. Each operator shall serve a maximum damper area of 36 square feet. Where larger dampers are used, provide multiple operators.

3.05 CONTROL VALVES

- A. All temperature control valves furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.
- B. Steam valve actuators shall be mounted at a 45 degree angle from upright vertical to prevent overheating of the actuator unless shielding is provided and the manufacturer indicates it is acceptable to mount in the upright vertical position. All other valves shall be mounted in the upright vertical position. If upright vertical mounting is not possible due to lack of space, obtain approval from the mechanical engineer of record on the project for alternate mounting that meet the manufacturers recommended installation.

3.06 ROOM THERMOSTATS AND TEMPERATURE SENSORS

- A. Check and verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Room sensors/thermostats shall be mounted at existing locations. Any new locations should be installed at ADA height (42-48") and aligned with wall switches. For drywall installations, thermostat mounting shall use a back-box attached to a wall stud, drywall anchors are not acceptable.
- B. Any room thermostats or sensors mounted on an exterior wall shall be mounted on a thermally insulated sub-base. Subbase to provide a minimum of one half inch of insulation.
- C. Where thermostats or sensors are mounted on exterior walls or in any location where air transfer will affect the measured temperature or humidity seal the conduit and any other opening that will affect the measurement.

3.07 ZONE CO2 SENSORS

- A. For rooms where a CO2 sensor and temperature sensor are both required, provide a combination device such that one wall sensor measures both temperature and CO2.

3.08 LOW LIMIT THERMOSTATS (FREEZESTATS)

- A. Install low limit controls where indicated on the drawings or as specified. Unless otherwise indicated, install sensing element on the downstream side of heating coils.
- B. Mount units using flanges and element holders. Provide duct collars or bushings where sensing capillary passes through sheetmetal housings or ductwork; seal this penetration to eliminate air leakage. Mount the units in an accessible location as to allow for resetting after low limit trips while still meeting manufacturer's installation requirements for proper function.
- C. Distribute (serpentine) sensing element horizontally across the coil to cover every square foot of coil; on larger coils this may require more than one instrument. Install controls at accessible location with mounting brackets and element duct collars where required.
- D. Integral Face and Bypass Steam Heating Coil Freezestats:

1. For integral face and bypass coils the elements are to be run vertically on the face of the heating coil inside the damper enclosure, this will require drilling the frame to run element around the by-pass. Provide an auto-reset freezestat for each coil vertical heating tube. The head of the freezestat shall be mounted outside the unit, if possible, above the coils and any excess capillary shall be mounted out of the air stream above the coil. If the head of the freezestat cannot be mounted outside of the unit, it should be mounted downstream of the coil. Provide latching relays with LED indicator of relay status for each freezestat so that the relay will remain latched after the freezestat resets. Label each freezestat and corresponding relay to provide an easy method to determine which freezestat(s) have tripped. Provide a momentary reset switch and connection for remote contact reset from the DDC system for resetting the freezestat alarm. The relays shall be unlatched after a power fail. Mount latching relays in a hinged cover panel mounted at a maximum of five feet above the floor in an accessible location on the AHU. Reset switch shall be mounted on the cover and be labeled "Freezestat Reset".

3.09 AIRFLOW STATIONS

- A. Install airflow stations in accordance with manufacturer's recommendations. Transmitter displays shall be mounted in accessible location for viewing and installation setup.

3.10 TEMPERATURE CONTROL PANELS

- A. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. All control panel openings shall be plugged. Conduits and other penetrations on the top of the cabinets shall be sealed on the exterior of the cabinet with silicone caulk to resist water penetration. One cabinet may accommodate more than one system in same equipment room. Provide permanent printed labeling for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face. Clear all debris and clean inside of cabinet at project closeout.
- B. Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover.

3.11 CURRENT STATUS SWITCHES

- A. Provide for each fan or pump specified, or shown on point list. Set threshold adjustment to indicate belt or coupling loss. Readjust threshold for proper operation after final balancing is completed. Use the variable frequency drive (VFD) integrated relay output for motor status, if provided on the VFD, in lieu of a discrete current switch. A separate current switch provided under this Section shall be wired in parallel with the VFD motor status relay when a bypass starter is provided on the VFD to prove motor status in the bypass mode.

END OF SECTION

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SECTION 23 09 93 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.
- B. Sequence of operation for:
 - 1. Hot Water System.
 - 2. Air Handling Units.
 - 3. Roof-Top Units.
 - 4. Exhaust Fan Systems.
 - 5. Air terminal units.
 - 6. Fan Coil Units.
 - 7. Zone Hot Water Coils.
 - 8. Unit Heaters.
 - 9. Emergency generators.

1.02 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Section 23 09 15 - DDC Points List
- C. Section 23 09 23 - Direct Digital Control (DDC) Systems
- D. Section 23 09 54 - Electric Temperature Control Systems

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Submit shop drawings for each system automatically controlled, containing the following information:
 - 1. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves and control devices. Indicate pneumatic piping; factory and field wiring.
 - 2. Label each control device with associated DDC point naming convention and applicable setting or adjustable range of control (e.g. HW-DP; 4-20mA/0-50psi).
 - 3. Indicate each control panel required, with internal and external piping and wiring clearly indicated. Provide detail of panel face, including controls, instruments and labeling.
 - 4. Include control narrative of the control sequence of each operation and interlocks with other operations.

- C. Maintenance Data: Include copy of "as-built" record shop drawings in each maintenance manual. Record drawings shall identify the location of concealed control devices by room number and location description.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL

- A. BACnet objects: All hardwired points listed in 23 09 15 and any setpoints, timers, or other control elements that are specified to be adjustable (adj.) in the following control sequences shall be mapped as BACnet objects and be available on the user interface to be adjusted. Consult with the user agency HVAC and/or DDC personnel prior to programming to determine if there are any items that they do not want to have mapped as BACnet objects. This is especially important for DDC controlled items that are duplicative, i.e. air terminal units.
- B. BACnet Addressing: BACnet instance ID's shall be coordinated with the agency's established BACnet instance ID addressing scheme. If there is not such a scheme in place, the contractor(s) providing BACnet DDC controllers shall work with the agency to establish such a scheme and document this in the asbuilt control drawings. BACnet/IP addressing shall be coordinated with the agency prior to installation. BACnet MS/TP addressing shall be addressed to provide for consecutive addressing to provide for the best speed of response.
- C. User Interface/Feature Software: Consult with the user agency HVAC and/or DDC personnel prior to programming to determine BACnet object naming conventions, user views, graphic layout, security matrix, alarming, trending, and scheduling preferences desired by the agency. Failure to consult and come to agreement prior to programming shall require the DDC contractor to make changes in the above listed items as desired by the user agency to the system at no cost.

- D. Setpoints: All setpoints indicated in the control specification are to be adjustable. The setpoints shall be readily available to be modified in the mechanical system software system summary (either textual or graphic based) and under the same software level as hardware points. Some less used setpoints may be provided on a lower software level, if requested by the user Agency for clarity. The setpoints indicated herein are only specified as a calculated starting point (or initial system operation). It is expected that setpoint adjustments and control loop tuning shall be required to provide optimum system operation based on requirements of the building. The control contractor shall work with the balancing contractor and the user Agency to provide the final system setpoint adjustments and control loop tuning after the system is in operation and building is in use. Document all final setpoints on the as-built control drawings. Any questions regarding the intended operation of the HVAC equipment and control systems shall be referred to the HVAC design engineer through the appropriate construction communication process. If the contractor fails to check with the user Agency for final setpoints, they shall adjust setpoints at no additional cost.
- E. Anti-Cycling: When HVAC equipment or a sequence is specified to be started and stopped by a temperature, humidity, pressure setpoint or any other controlled variable, there shall be an adjustable differential setpoint that shall be set to prevent short cycling of the systems and equipment due to minor changes in the controlled variable. Temperature differential setpoints shall be set at 2°F. Humidity setpoints shall be set at 5% of the controlled range unless otherwise specified. Setpoints shall indicate at when the process should be turned on. Heating and cooling differentials shall be set for above setpoint and will be used to turn the process off. For example, an economizer sequence called to switch at 68°F, would turn on at 68°F and off at 70°F since it is a cooling function. A heating lockout setpoint of 50°F would turn on heating control at 50°F and off at 52°F. Non-temperature differentials shall be set above setpoint if the setpoint is indicating a minimum value or below setpoint if the setpoint is indicating a maximum value. Provide minimum runtime timers for loads that are cycled to prevent over-cycling. Timers shall be set as specified or as needed to prevent damage or excessive wear to the equipment. Unless otherwise specified in the individual control sequences, fans and pumps shall have a minimum runtime on timers of 15 minutes (adj.) and off timers of 5 minutes (adj.). Safeties shall override runtime timers.
- F. Deadbands: Provide deadbands for all DDC control loops to prevent constant hunting of output signals to controlled devices. Deadbands shall be set to provide adequate control around setpoint as follows unless otherwise specified in the individual control sequences:
1. Temperature Control: $\pm 0.5^{\circ}$ F
 2. Humidity Control: $\pm 1\%$ RH
 3. Airflow Control: $\pm 2\%$ of total flow
 4. AHU Static Pressure Control: ± 0.01 in. w.c.

G. Alarms

1. Provide all alarmed points with adjustable time delays to prevent nuisance tripping under normal operation and on equipment start-up. For all commanded outputs that have status feedback, provide an alarm that shall indicate the commanded output is not in its commanded state. Provide alarms on all points as indicated on 23 09 15 DDC point charts.
2. For devices that have form "C" contacts available for alarm monitoring, use closed contacts for the Normal condition and open contacts on Alarm condition. This shall provide a level of supervision by detecting a break in the wiring.

H. Lead/Lag Sequencing: For sequences that call for lead/lag of equipment connected to building automation systems, the lead device shall be able to be chosen through a selectable day of the week and time of day through the building automation system. Coordinate with the user Agency for scheduling switchover and frequency. Unless otherwise directed, switchover of equipment shall occur at 10AM Tuesday and shall rotate the lead device on a weekly cycle rotating through all devices sequentially.

I. Variable Frequency Drive (VFD) Motor Run Status: Use the VFD programmable relay dry contact output specified to be provided with the VFD to prove motor run status and detect belt loss or coupling break. If a bypass contactor is provided with the VFD, provide an adjustable current switch and wire it in parallel with the VFD output for proving motor status.

J. VFD Bypass and Safety Interlocks: VFD's equipped with bypass starters shall be interlocked so that the start/stop and safety circuits that are called out for VFD operation shall be functional when the VFD is indexed to the bypass starter mode. Unless otherwise specified in the sequence below, the switch from inverter to bypass starter modes shall be through a manual switch provided on the VFD/bypass starter package.

K. Damper Interlocks for Fans with Starters: For fan systems with magnetic starters and shutoff dampers specified with end switches, the damper interlock shall be hardwired in such a way that the damper shall open if the fan starter hand / off / auto switch is in the hand or in the auto position and being called to start. After the damper end switch has proven the damper open, a hardwire interlock from the end switch to the starter holding coil for the fan shall cause the fan to start. For fan systems that are ducted in parallel, see specific sequence for fan system on interlock requirements.

L. Damper Interlocks for Fans with VFD's:

1. For fan systems with VFD's and shutoff dampers specified with end switches, the damper end switches shall be hardwire interlocked to the safety circuit(s) of the VFD to prevent the fan from starting until the damper is proven open. This interlock shall prevent the fan from running in either the VFD or bypass (if provided) mode. The damper end switch shall also be monitored by the DDC system. For fan systems that are ducted in parallel, see specific sequence for fan system on additional interlock requirements.
- M. Thermostats and Sensors: All devices and equipment including terminal units, specified to be controlled in a control sequence by a thermostat or sensor, shall be provided with a thermostat or sensor, whether or not the device is indicated on the plans.

3.02 HOT WATER SEQUENCE OF OPERATIONS

- A. General:
 1. Furnish and install a panel mounted DDC and controls devices (relays, current sensors, temperature sensors, pressure sensors, etc.) as depicted on HVAC controls schematics in plans in order to provide a fully-functional, controlled system.
 2. The hot water system is configured in a primary-secondary configuration with variable volume secondary pumps from an existing central boiler plant.
- B. Hot Water System Pumps:
 1. The building is served by two system hot water pumps that operate in a lead/lag/standby fashion. The building pumps are connected to an existing secondary heating hot water system with boiler and pumps located in the adjacent building. Control of the existing boilers and secondary pumps are to remain.
 2. The BAS shall modulate the variable frequency drive serving the respective pump(s) to maintain the system differential water pressure sensor at or above its respective setpoint of [10] psi (adj.). Work with TAB contractor to obtain the differential pressure setpoint for the sensor.
 3. Pumps shall operate in a lead/lag/standby fashion and shall run continuously. If the lead or lag hot water pump fails, the standby pump will automatically start and an alarm shall be provided at the BAS.
 4. When lead hot water pump speed has been greater than 80% for more than 10 minutes (adj.), the lag hot water pump shall be started and both pumps shall be commanded from a starting point of 40% speed. Both pumps shall be modulated in unison to maintain system differential pressure setpoint, as measure at the DPT with the lowest reading. When both pumps have modulated below 30% speed for more than 10 minutes (adj.), the lag pump shall be commanded off and the lead pump shall provide differential pressure control.

5. Provide a graphical button that allows manual selections of the lead, lag, and standby pumps for service. Lead, lag, and standby assignments shall rotate weekly to equalize runtime.

3.03 AIR HANDLING UNIT SYSTEMS

- A. Variable Volume Air Handling Unit Control (AHU-1 ,2 and 3, RAHU-1,2)
 1. AHU control scope includes DDC control for new units and control retrofit of existing units. Refer to control diagrams and drawings for extent of new control devices.
 2. General:
 - a. The Air Handling Unit is controlled by Direct Digital Controls (DDC)
 - b. The Air Handling Unit serves VAV Boxes .
 - c. The AHU controls contains the following:
 - 1) Supply fan with VFD.
 - 2) Exhaust fan with VFD (external to unit).
 - 3) Fail-closed modulating outside air damper, fail-open modulating return air damper, and fail-closed relief air damper and actuator. Dampers shown in ductwork are furnished by this contractor, dampers included within the equipment or with roof exhaust fans are furnished by the manufacturer or are existing to remain; all actuators are furnished by this contractor.
 - 4) Hot water coil valve and modulating actuator for heating with freeze protection coil circulating pump.
 - 5) Chilled water coil valve and modulating actuator for cooling and dehumidification.
 - 6) Discharge air, return air and mixed air temperature sensors.
 - 7) Return air humidity sensor.
 - 8) Duct mounted static pressure sensor.
 - 9) High limit static pressure sensor.
 - 10) Smoke detector (furnished by E.C.).
 - 11) Filter air pressure drop differential sensor.
 - 12) Fan status feedback.
 - 13) Freeze protection thermostat.
 3. Ventilation (Outdoor Air) Air Flow Control:

- a. When the AHU is operating in the occupied mode, the outdoor air damper and return air damper shall be controlled to maintain the minimum ventilation airflow setpoint. The return air damper shall always modulate opposite of the outside air damper. When the economizer sequence is not enabled, the outside air damper and return air damper shall modulate to maintain the outside air flow ventilation rate setpoint. When the economizer sequence is enabled, the outside air and return air dampers shall modulate as described below under "Discharge Air Temperature Control" but shall be limited from controlling below the minimum outside air ventilation flow rate.
 - b. Ventilation Airflow Setpoint: The AHU outside air ventilation rate shall be the minimum flow rate as scheduled in the plans.
4. Discharge Air Temperature Control:
- a. Install a temperature sensor in the supply duct downstream of the supply fan, all coils, and humidifiers. The hot water heating coil, outdoor air damper and return air dampers, and chilled water coil shall be controlled in sequence to maintain the discharge air temperature setpoint. At no time shall the heating coil be operating when the mixed air dampers are economizing or the chilled water coil valve is open.
 - b. Discharge air temperature setpoint: Discharge air temperature setpoint shall be reset between 53°F and 65°F (adj.). The DDC system shall poll the supply VAV terminal operation and the RTU return air humidity and reset the discharge air temperature up in 0.5°F increments every 5 minutes and down in 1°F increments every 5 minutes. When none of the associated VAV boxes are at their maximum flow (except those that are constant volume – those shall be negated) and the return air humidity is below 53%RH, the discharge air temperature setpoint shall be reset up. When any of the associated VAV terminals are at 100% design airflow or the return air humidity rises above 58%RH, the system discharge air temperature setpoint shall be reset down.
 - c. Whenever the discharge air temperature is above the setpoint, the following shall occur in sequence: The heating coil control valve shall modulate closed as sequenced below. When heating is completely off and the economizer sequence is enabled, the economizer outside air damper and return air damper shall be modulated to maintain the discharge air temperature setpoint. When the outside air economizer damper is completely open and the return air damper is completely closed, or the economizer sequence is not enabled, the chilled water valve shall modulate open to maintain the discharge air temperature setpoint. When the discharge air setpoint is below setpoint the reverse shall occur and the heating coil control valve shall modulate to maintain discharge air temperature setpoint. Cooling coil control shall be locked out below 50° F (adj.) outside air temperature.

5. Pumped Hot Water Heating Coil Control:
 - a. Modulate the hot water control valve as sequenced under discharge air control. Start hot water pump whenever mixed air temperature is below 45° F (adj.). Stop hot water pump whenever mixed air temperature is above 45° F (adj.).
6. Economizer Control:
 - a. Economizer shall be enabled whenever outdoor air temperature is less than 70°F (adj.).
7. Relief Air Damper and Exhaust Fan Control:
 - a. Install a building static pressure sensor to control the relief air damper and exhaust fan (external to unit). Locate the static pressure sensor away from any air intake or exhaust airstreams.
 - b. When the building static pressure rises above +0.05"WC (adj.), the relief air damper shall be commanded open. Upon a further increase in building static pressure, the exhaust fan VFD shall be modulated to maintain the building pressure at a setpoint of +0.02"WC (adj.). The relief damper shall be open anytime the exhaust fan is on.
8. Dehumidification Control:
 - a. The discharge air temperature shall be reset as described above under "Discharge Air Temperature Control" to dehumidify the supply air by lowering the discharge air temperature, based on return air humidity.
9. Filters:
 - a. Install a differential static pressure sensor across each filter bank. Ensure that the static probes do not impede filter removal.
 - b. For MERV 8 filter bank, provide an alarm at the BAS when the differential static pressure exceeds 1.00" w.c. (adj.).
 - c. For MERV 13 filter bank, annunciate an alarm at the BAS when the differential static pressure exceeds 1.5" w.c. (adj.).
10. Unoccupied Control:
 - a. Occupied/unoccupied schedule shall be set at the BAS. Preliminary schedule shall be determined in coordination with the facility owner. When indexed to unoccupied, the unit shall shutdown. Index VAV boxes associated with this AHU to maintain setback and start-up temperature setpoints during unoccupied mode.

- 1) Night Setback Heating: If the space temperature in any of the VAV zones served drops below its unoccupied heating setpoint, all VAV Boxes shall be commanded to operate between their occupied minimum CFM setpoints and heating and cooling maximums. The supply fan shall start, the outdoor air and exhaust air dampers shall remain closed, the return air damper shall be open, and the heating coil valve shall modulate to provide heat. The relief fan shall be off. When the space temperature rises above the unoccupied heating setpoint, the AHU shall stop and all VAV Boxes shall go to their unoccupied minimum CFM setpoints. Provide a minimum runtime of 15 minutes (adj.).
 - 2) Night Setback Cooling: If the space temperature in any of the VAV zones rises above its unoccupied cooling setpoint, all VAV Boxes shall be commanded to operate between their occupied minimum CFM setpoints and heating and cooling maximums. The supply fan shall start. The outdoor air and exhaust air dampers shall remain closed, the return air damper shall be open, the relief fan shall be off, and the cooling coil valve shall be modulated to maintain the discharge air setpoint. Provide a minimum runtime of 15 minutes (adj.).
- b. Heating Optimum Start-Up:
- 1) This cycle shall override the unoccupied cycle. If the system was operating as a result of the unoccupied cycle, the system shall continue to operate. The BAS shall measure the outside air dry bulb temperature to determine the minimum run time to warm the zone to its setpoint. When the computed start time is reached, the DDC system shall start the Air Handling Unit and operate with the outside air and relief air dampers closed and the return air damper open. The Air Handling Unit discharge air temperature shall be controlled as specified under Discharge Air Temperature Control. When the occupied time is reached, the unit shall be switched to occupied control and ventilation air shall be provided.
 - 2) Anytime the unit is on for heating optimum start-up, all VAV boxes shall be overridden open to their occupied minimum flow values for minimum flow (instead of their scheduled unoccupied minimum airflow value) and modulated between their occupied minimum and heating and cooling maximum airflows.
- c. Cooling Optimum Start-Up:
- 1) This cycle shall override the unoccupied cycle. If the system was operating as a result of the unoccupied cycle, the system shall continue to operate. The BAS shall measure the outside air dry bulb temperature to determine the minimum run time to cool the zone to its setpoint. When the computed start time is reached, the DDC system shall start the Air Handling Unit. When the occupied time is reached, the unit shall be switched to occupied control and ventilation air shall be provided.
 - 2) Anytime the unit is on for cooling optimum start-up, all VAV boxes shall be overridden open to their occupied minimum flow values for minimum flow (instead of their scheduled unoccupied minimum airflow value) and modulated between their occupied minimum and heating and cooling maximum airflows.

11. Safeties:

- a. General: All safeties shall be hard wired to the supply fan starter or VFD safety circuits except where noted to be a software shutdown only. Starters shall not function in the "Hand" or "Auto" and VFD's shall be disabled if they are indexed to the "Auto" or "Hand" position in either the VFD or bypass modes. All alarms shall be annunciated at the BAS in addition to unit shutdown.
 - b. Fire Alarm Shutdown: Upon a fire alarm system alarm, the fire alarm control module provided by the electrical contractor at the temperature control panel shall change its state of contacts. This shall cause the unit to be shut down (see Unit Shutdown for additional information) and all fire/smoke and smoke dampers within this system shall close immediately through a hardwire interlock.
 - c. Low Limit Temperature (software shutdown only): If the unit discharge air temperature drops below 38°F (adj), the AHU shall be commanded off by the BAS and an alarm shall be sent to the BAS. Provide a graphical reset button that puts the AHU back into service after this event.
 - d. Freezestat: Install an electric freezestat to shut down the unit (see Unit Shutdown for additional information) if the temperature downstream of the heating coil drops below 35° F (adj.). The electric freezestat shall act independently of the DDC system via hardwire interlock and shall override the DDC system control signal to open the heating coil control valve(s). A freezestat trip shall notify the DDC system that shall send an alarm to the BAS.
 - e. Supply Fan High Pressure Limit: Install a static pressure probe located in the air handling unit main discharge duct at least six feet or as far as physically possible downstream of the fan and upstream of any dampers and pipe to a differential pressure switch located in the temperature control panel. Wire in series with the safety circuit of the supply and return fan. Differential pressure switch shall be a manual reset type and the DDC system shall monitor the status of the differential pressure switch. Initial setpoint shall be +3.5" w.c. (adj.).
 - f. Smoke Detector Shutdown: Upon activation of the smoke detector in the RTU return duct, this shall cause the supply and return fan to be off via a hardwired interlock and the unit to be shut down (see Unit Shutdown for additional information). An auxiliary contact shall be provided to notify the DDC system of a smoke detector shutdown.
12. Unit Shutdown:
- a. Whenever the Air Handling Unit is off, the following shall occur:
 - 1) The supply fan shall be off.
 - 2) The relief fan shall be off.
 - 3) The outside air damper and relief air damper shall close and the return damper shall open.

- 4) The chilled water control valve shall close.
- 5) The heating coil control valve shall remain under control from the mixed air sensor to maintain 55°F (adj). Freezestat shall override heating control valve open.

3.04 ROOF TOP UNITS

A. Variable Volume Roof-Top Unit Control (RTU-1)

1. General:

- a. The Roof-Top Unit is variable air volume but will operate as constant airflow, packaged unit for roof installation.
- b. The Roof-Top Unit is controlled by Direct Digital Controls (DDC) provided by this contractor.
- c. The Roof-Top Unit serves zone heating coils.
- d. The Roof-Top Unit controls contains the following:
 - 1) Supply with VFD
 - 2) Exhaust fan with VFD
 - 3) Fail-closed modulating outside air damper, fail-open modulating return air damper. Dampers and actuators provided with unit by manufacturer.
 - 4) DX coil for cooling and dehumidification.
 - 5) Return air humidity sensor.
 - 6) Duct mounted static pressure sensor.
 - 7) High limit static pressure sensor.
 - 8) Filter air pressure drop differential sensor.
 - 9) Fan status feedback.
 - 10) Terminal strip for DDC control of unit by BAS.
 - 11) Smoke detector (furnished by E.C.).

2. Supply Fan Control:

- a. Start/Stop: Provide a user-defined building occupancy schedule. Preliminary schedule shall be determined in coordination with the facility owner. During occupied mode, the supply fan shall operate continuously. The supply fan shall be off in the unoccupied mode except as described below for night setback cycling and optimal start.
- b. Supply Fan Speed Control: The supply fan operates at constant volume with variable speed drive for balancing purposes and future VAV conversion.

- c. Static Pressure Reset Control: Static pressure setpoint shall be reset using Trim & Respond logic within the range 0.15 in. W.C. to 1.25 in. w.c. (adj.) When the fan is off, the setpoint shall be reset to 0.8 in. w.c. (adj.) and this setpoint shall be used on system start up while the fan is proven on, every two minutes, trim the setpoint by 0.04 in. w.c. if there are two or fewer zone pressure requests. If there are more than two zone pressure requests, respond by increasing the setpoint by 0.06 in. w.c.
- 3. Exhaust Fan Control:
 - a. Start/Stop and Exhaust Fan Speed Control: The exhaust fan shall be commanded through the DDC system and shall modulate the exhaust fan VFD to maintain the building static pressure setpoint.
 - b. When the building static pressure rises above +0.05"WC (adj.), the relief air damper shall be commanded open. Upon a further increase in building static pressure, the exhaust fan VFD shall be modulated to maintain the building pressure at a setpoint of +0.02"WC (adj.). The relief damper shall be open anytime the exhaust fan is on.
- 4. Mixed Air Dampers and Ventilation Air Control:
 - a. When outdoor air temperature is between the discharge air temperature setpoint and economizer setpoint of 70°F, the outdoor air damper shall be 100% open for economizer and the return air damper closed.
 - b. When the outdoor air temperature is above 70°F, the mixed air dampers shall modulate to maintain the required ventilation levels as scheduled in the plans.
 - c. When the outdoor air temperature is below the discharge air temperature setpoint, the mixed air dampers shall modulate to maintain discharge air temperature setpoint, subject to the required ventilation levels.
- 5. Discharge Air Temperature Control:
 - a. Install a temperature sensor in the supply duct downstream of all coils.
 - b. Discharge Air Temperature Control: The mixed air dampers, heating coil, and the cooling coil shall be controlled in sequence to maintain the discharge air setpoint temperature. Whenever the discharge air temperature is above the setpoint, the following shall occur in sequence: When the economizer sequence is enabled, the economizer outside air damper and return air damper shall be modulated together to maintain discharge air temperature setpoint, subject to ventilation levels. When the outside air economizer damper is completely open, or the economizer sequence is not enabled, the cooling coil valve shall modulate to maintain the discharge air temperature setpoint. When the discharge air setpoint is below setpoint the reverse shall occur. The heating coil valve will be off anytime the unit is economizing or the cooling coil is operating in the cooling mode.
- 6. Economizer Control:

- a. When the economizer sequence is enabled by the switchover sequence below, the outside air damper and return air damper will modulate to provide outside air to be used for free cooling. The dampers will modulate in sequence with the cooling coil as described in the discharge air temperature control sequence above. The heating coil shall be energized off when economizer dampers are open for cooling.
 - b. Fixed Dry Bulb Economizer Switchover: The economizer sequence shall be enabled whenever the outside air temperature is less than 70° F (adj.).
7. Filters:
 - a. Monitor the RTU's dirty filter switch and provide an alarm to the operator interface when the switch is in alarm.
8. Safeties:
 - a. General: All safeties shall be hard wired to the supply and exhaust fan VFD safety circuits. Starters shall not function in the "Hand" or "Auto" and VFD's shall be disabled if they are indexed to the "Auto" or "Hand" position in either the VFD or bypass modes.
 - b. Supply Fan High Pressure Limit: Install a static pressure probe located in the Roof-Top Unit main discharge duct at least six feet or as far as physically possible downstream of the fan and upstream of any dampers and pipe to a differential pressure switch located in the temperature control panel. Wire in series with the safety circuit of the supply fan. Differential pressure switch shall be a manual reset type and the DDC system shall monitor the status of the differential pressure switch. Initial setpoint shall be +3.5" W.C. (adj.)
 - c. Return Air Low Pressure Limit: Install a static pressure probe located in the return ductwork and pipe to a differential pressure switch located in the temperature control panel. Wire in series with the safety circuit of the supply and exhaust fans. Differential pressure switch shall be a manual reset type and the DDC system shall monitor the status of the differential pressure switch. Initial setpoint shall be - 3.5" w.c. (adj.).
 - d. Smoke Detector Shutdown: Upon activation of the smoke detector in the RTU return duct, this shall cause the supply and return fan to be off via a hardwired interlock and the unit to be shut down (see Unit Shutdown for additional information). An auxiliary contact shall be provided to notify the DDC system of a smoke detector shutdown.
9. Unit Shutdown:
 - a. Whenever the Roof-Top Unit is off, the following shall occur:
 - 1) The supply and exhaust fans shall be off.
 - 2) The outside air dampers and exhaust air dampers shall close and the return dampers shall open.

- 3) The cooling coil compressors shall be off.

3.05 EXHAUST FANS

A. General Exhaust Fan:

1. System consists of multiple existing or new constant volume exhaust fans with motorized isolation dampers, furnished by the manufacturer or existing to remain. VFD/ECM for balancing purposes only.
2. Exhaust fan shall be commanded on by the BAS to run based on the occupancy schedule. Interlock damper to open with fan operation.

B. Light Well Exhaust Fan Cooling:

1. System consists of two existing constant volume exhaust fan with isolation dampers wired to each fan and two existing transfer air ducts with new dampers and actuators furnished by this contractor. Provide a new space DDC sensor within the light well zone.
2. When the DDC space temperature sensor rises above 80°F (adj), the BAS shall command on the exhaust fan and open the transfer duct damper. Interlock exhaust fan with exhaust isolation damper. When the room temperature drops below 75°F (adj), the fan shall be off. Any time the exhaust fan is called to run, provide a 15-minute minimum runtime on the fan before the fan is allowed to turn off.

3.06 AIR TERMINAL UNITS

A. VAV Terminal Unit with Reheat:

1. Provide a DDC space temperature sensor to control, in sequence, a modulating electronic control valve for the hot water reheat coil and actuator for terminal air flow. On a rise in temperature above the room temperature setpoint, the reheat coil will modulate closed. On a further rise in temperature, the VAV box will be modulated open beyond the minimum CFM towards the maximum cooling CFM in order to maintain the desired room temperature setpoint. When space temperature is below setpoint, the air terminal damper shall modulate toward the cooling minimum flow position. After the air terminal damper is at its minimum flow, the hot water valve shall modulate open to maintain space temperature, while limiting the discharge air temperature from exceeding 90°F. If the discharge air temperature is at 90°F and there is still a call for heating, the air terminal damper shall modulate towards the heating maximum flow position and the control valve shall be released to maintain room temperature.
2. The heating coil valve shall be commanded closed whenever the associated AHU/RTU is off. When the space temperature is between the heating and cooling setpoints, the heating valve shall be closed and the supply airflow at minimum flow.

3. Radiation Control: For zones with associated radiation, when space temperature is below setpoint, the air terminal damper shall modulate toward the cooling minimum flow position. On a further call for heat, modulate radiant hot water valve open as the first stage of heat. If valve is 100% open and there is a further call for heating, the reheat coil shall be modulated open as the second stage of heat to maintain space temperature. On a further call for heating after the hot water reheat valve is 100% open, the air terminal damper shall modulate up to the maximum heating flow (where scheduled). The reverse shall occur when space temperature is above setpoint. Lock hot water radiation valve closed whenever outside air is above 50° F (adj.).
4. Unoccupied/Standby Heating Control with Radiation: If there is a call for zone heating, the associated radiation terminal shall be modulated to maintain the unoccupied/standby zone temperature. If there is a further call for heating, the VAV terminal shall modulate between the minimum and heating maximum occupied airflow rates and the heating valve controlled to maintain zone setpoint
5. Unoccupied/Standby Heating Control without Radiation: When there is a call for zone heating, the VAV terminal shall modulate between the minimum and heating maximum occupied airflow rates and the heating valve controlled to maintain zone setpoint.
6. Demand Control Ventilation: For zones that show a CO2 sensor on the plans, the minimum box CFM shall be overridden based on the CO2 sensor reading in the occupied mode. When the space is scheduled to the occupied mode, the minimum box CFM shall be overridden and reset between the scheduled minimum airflow up to the heating maximum airflow as CO2 in the space goes between 500ppm and 1200ppm.
7. Hot water coil freeze protection sequence - VAV 2-15 located in the attic: When its associated air handling unit is off, monitor the discharge air temperature sensor and modulate the hot water heating control valve to maintain 60F inside the duct.

3.07 ZONE HOT WATER HEATING COILS:

- A. Provide a DDC space temperature sensor to control a modulating electronic control hot water valve to maintain space temperature. When space temperature is below setpoint, modulate the hot water valve open. The reverse shall occur when space temperature is above setpoint.
- B. Provide separate adjustable heating setpoints for both the occupied and unoccupied modes.

3.08 FAN COIL HEATING/COOLING:

- A. Provide a DDC space temperature sensor to control modulating control valves for hot water and for chilled water to maintain space temperature. Provide separate heating and cooling setpoints. When the space temperature is below setpoint, the DDC controller shall modulate the chilled water valve closed. When the chilled water valve is fully closed the hot water valve shall modulate open to maintain setpoint. When the space temperature is above setpoint, the DDC controller shall modulate the hot water valve closed. When the hot water valve is fully closed, the chilled water valve shall modulate open to maintain setpoint.
- B. Provide a DDC space temperature sensor and discharge air temperature sensor to control, in sequence, an ECM fan, and modulating control valves for hot water and for chilled water to maintain space temperature. Reset the discharge air temperature setpoint based on the zone temperature between 55° F (adj.) and 85°F to maintain the zone heating and cooling setpoints. When the space temperature is below setpoint, the DDC controller shall start the fan at minimum speed and modulate the chilled water valve closed. When the chilled water valve is fully closed the hot water valve shall modulate open to maintain target discharge air setpoint. If the heating valve is opened 100% and there is still a call for heating, the fan speed shall be modulated upwards to maintain setpoint. When the space temperature is above setpoint, the following shall occur in sequence: The fan shall start at minimum speed and the chilled water valve shall modulate open to maintain the space temperature setpoint. Modulate fan speed upwards as the final stage of cooling. When space is satisfied fan shall be off. Provide a minimum runtime of 15 minutes (adj.) to prevent short-cycling. The heating and cooling coil valves shall be commanded closed whenever the fan coil fan is off.
- C. Provide DDC start/stop for fan control. Cycle fan on when calling for heating or cooling. When space is satisfied fan shall be off.
- D. Provide a discharge temperature for monitoring purposes. The heating and cooling coil valves shall be commanded closed whenever the fan coil fan is off.

3.09 HOT WATER UNIT HEATERS:

- A. Provide DDC space temperature sensor to control the hot water control valve to maintain space temperature. As temperature rises above setpoint, the control valve shall be closed. On a call for heating, the hot water valve shall be open. Provide a strap-on aquastat on the hot water return line set at 100°F to control the unit fan whenever the hot water temperature is above setpoint.

3.10 EMERGENCY GENERATORS

- A. Provide BAS integration and monitoring of the generator. Points to be monitored and alarmed, at a minimum, include: Generator Status, Run, Trouble, and Fuel Level.

3.11 FINAL ADJUSTMENT OF EQUIPMENT

- A. After completion of installation of the DDC equipment, calibrate and adjust setpoints of the equipment provided as work of this section.
- B. All controllers, relays, sensors/transmitters, wiring leads, and other devices shall be neatly identified as to function and adjustment (with final setpoint marked and numerically identified).
- C. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of the control system.

END OF SECTION 23 09 93

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SECTION 23 21 13 - HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping.
- C. Make-up water.
- D. Drain piping.
- E. Chilled water piping.
- F. Unions, flanges, and dielectric connections.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
- B. Section 23 07 19 - HVAC Piping Insulation.
- C. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- D. ASME B31.9 - Building Services Piping.
- E. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- H. ASTM B32 - Standard Specification for Solder Metal.
- I. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- J. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- K. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- L. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- M. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

- B. Product Data:
 - 1. Include data on pipe materials, pipe fittings, and accessories.
 - 2. Indicate valve data and ratings.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Project Record Documents: Record actual locations of valves.
- E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Welder Qualifications:
 - 1. Welding procedures, welders, and welding operators for all building service piping to be in accordance with certified welding procedures of the National Certified Pipe Welding Bureau.
 - 2. The Architect, Engineer or Owner reserves the right to test the work of any welder employed on the project, at the Contractor's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.

2. Isolate equipment using butterfly valves with lug end flanges.
 3. For throttling, bypass, or manual flow control services, use ball or butterfly valves.
 4. For throttling and isolation service in chilled water systems, use only butterfly valves.
 5. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.
- F. "Weldolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

2.02 HEATING WATER PIPING

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 2. Threaded Joints: ASME B16.3, malleable iron fittings.
- B. Copper Tube: ASTM B88, Type K, drawn, using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Apollo Valves: www.apollovalves.com/#sle.
 - 2) Grinnell Products: www.grinnell.com/#sle.

2.03 CHILLED WATER PIPING

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 2. Threaded Joints: ASME B16.3, malleable iron fittings.
- B. Copper Tube: ASTM B88, Type K, hard drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Apollo Valves

2) Grinnell Products

2.04 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
 - 1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.

2.05 UNIONS, FLANGES, DIELECTRIC CONNECTIONS

- A. Unions for Pipe of 2 Inches and Less:
 - 1. Ferrous Piping: 150 psi brass or malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 1/2 Inches and Greater:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick, preformed neoprene.
- C. Dielectric Connections: Utilize brass or bronze threaded ball valves at transitions between steel mains and copper branch connections to limit the effects of galvanic action.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe. Tubing end shall be clean and dry.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment using jointing system specified.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. See Section 23 25 00 for additional requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space, to avoid interfere with use of space, and at heights which do not obstruct other trades or any portion of a window, doorway, stairway, or passageway.
- D. Group piping whenever practical at common elevations.
- E. Slope piping and arrange to drain at low points.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 07 19.
- H. Use eccentric reducers to maintain top of pipe level.
- I. Connect branch piping to mains at 90 degree angle upward.
- J. Do not route piping through transformer vaults, elevator equipment rooms, or above transformers, panel boards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment. Where the above condition is unavoidable, provide drain pan and side shields to protect equipment from dripping or spraying.
- K. Use a thread lubricant or Teflon tape when making threaded pipe joints; no hard setting pipe thread cement or caulking will be allowed.

END OF SECTION

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SECTION 23 21 14 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air and dirt separators.
- D. Strainers.
- E. Suction diffusers.
- F. Pressure-temperature test plugs.
- G. Balancing valves.
- H. Flow meters.
- I. Relief valves.

1.02 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Project Record Documents: Record actual locations of flow controls.
- F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol
 - 2. ITT Bell & Gossett
 - 3. Taco
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. ASME stamped for 125 PSIG working pressure.
- C. Vertical pressurized steel tank.
- D. Each complete with replaceable heavy duty butyl rubber bladder, 1-1/2" system connection, 3/4" drain connection, charging valve connection and lifting ring and floor mounting skirt for vertical mounting.
- E. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi, and steel support stand.
- F. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong
 - 2. ITT Bell & Gossett
 - 3. Taco
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Manual Air Vent: Short vertical sections of pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Air Vent:
 - 1. High capacity air vent rated for 150 PSIG at a maximum temperature of 250 deg.
 - F. Constructed of cast iron body and fitted with components of stainless steel, brass and EPDM.

2.03 AIR SEPARATORS

- A. Air and Dirt Separators:
 - 1. Manufacturers:
 - a. Armstrong
 - b. ITT Bell & Gossett
 - c. Spirotherm
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Furnish in-line air and dirt separator of size indicated with steel body, stainless steel coalescing medium, bottom collection chamber, removable top air vent, side-tap hose connection, minimum 1" bottom blow-down tapping with ball valve, ASME constructed and stamped for 150 PSIG working pressure with flanged connections.
3. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to top of separator.
4. End Connections: Class 150 flanged for 2-1/2 inch and larger otherwise threaded.
5. Blowdown Connection: Threaded.
6. Size: Match system flow capacity.
7. Maximum Fluid Service Pressure: 150 psi.
8. Maximum Fluid Service Temperature: 250 degrees F.

2.04 STRAINERS

- A. Manufacturers:
 1. Armstrong
 2. Grinnell
 3. Nexus Valve
 4. The Metraflex Company: www.metroflex.com/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Size 2 inch and Under:
 1. Provide threaded or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.
 2. Body Material by Fluid Service:
 - a. Cast Iron or Brass:
 - 1) Liquids: Up to 400 psi at 150 degrees F.
- C. Size 2-1/2 inch to 4 inch:
 1. Provide iron body for 175 psi working pressure, Y pattern with 1/16 inch stainless steel perforated screen.
 2. Body Material by Fluid Service:
 - a. Cast Iron:
 - 1) Liquids: Up to 200 psi at 150 degrees F.
- D. Accessories: Provide air vent, hanging tag, outlet ball valve, and PT test plug extension.

2.05 SUCTION DIFFUSERS

- A. Manufacturers:
 1. Bell & Gossett
 2. Grinnell
 3. Victaulic

4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Furnish cast iron angle type body with steel inlet vanes, steel combination diffuser strainer and orifice plate and a number 16 mesh bronze start-up strainer, which is to be removed after initial 30-days of operation, an adjustable foot support to carry the weight of the suction piping and inlet flange or gauge part pressure gauge tapings. Discharge pipe size of suction diffuser to be same size as pump inlet.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.06 PRESSURE-TEMPERATURE TEST PLUGS

- A. Manufacturers:
 1. Peterson Equipment Company Inc: www.petesplug.com/#sle.
 2. Sisco Manufacturing Company Inc: www.siscomfg.com/#sle.
- B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- C. Application: Use extended length plugs to clear insulated piping.

2.07 BALANCING VALVES

- A. Manufacturers:
 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 2. Ferguson Enterprises Inc: www.fnw.com/#sle.
 3. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 4. Nexus Valve, Inc: www.nexusvalve.com/#sle.
 5. Oventrop Corporation; Hydrocontrol F: www.ventrop.com/#sle.
 6. Taco, Inc: www.taco-hvac.com/#sle.
 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Size 2 inch and Smaller:
 1. Provide style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, or press connections.
 2. Metal construction materials consist of bronze or brass.
 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- C. Size 2-1/2 inch and Larger:
 1. Provide butterfly style with integrated flow orifice or pitot style flow meter, shut-off capabilities, memory stops, and flanged or grooved connections.
 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

2.08 FLOW METERS

- A. Manufacturers:

1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 2. EMCO Flow Systems: www.emcoflow.com/#sle.
 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Direct reading with insert pitot tube, threaded coupling, for 150 psi working pressure, maximum 240 degrees F, 5 percent accuracy.
- C. Cast iron, wafer type, orifice insert flow meter for 250 psi working pressure, with read-out valves equipped with integral check valves with gasketed caps.

2.09 RELIEF VALVES

- A. Manufacturers:
1. Apollo
 2. Armstrong
 3. ITT Bell & Gossett
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified, labeled and factory set for 30 PSIG.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points and as indicated.
- C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- D. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- E. Provide valved drain and hose connection on strainer blowdown connection.
- F. Provide pump suction fitting on suction side of base-mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- G. Support pump fittings with floor-mounted pipe and flange supports.
- H. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- I. Pipe relief valve outlet to nearest floor drain.

END OF SECTION

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SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line pumps.
- B. End-suction pumps.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- C. Section 23 09 23 - Direct-Digital Control System for HVAC.
- D. Section 23 09 34 - Variable-Frequency Motor Controllers for HVAC.

1.03 REFERENCE STANDARDS

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

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Armstrong Fluid Technology, Inc: www.armstrongfluidtechnology.com/#sle.
- B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com/#sle.
- C. Grundfos Pumps Corporation: www.grundfos.com/#sle.
- D. Wilo.
- E. Taco Comfort Solutions.
- F. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Electrical Requirements:
 - 1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
 - 2. Variable Frequency Drives (VFDs): Provide in accordance with Section 23 09 34, except for integral-VFDs.
 - 3. Enclosures: Provide unspecified product(s) required to fit motor:

2.03 IN-LINE PUMPS

- A. Closed-Coupled, Single-Stage Pump: Vertical pump with radially- or horizontally-split casing; rated for discharge pressures up to 175 psi.
- B. Casing: Cast iron with seal flush connection, threaded suction, and discharge ports with gauge port and drain plug.
- C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- E. Electrical:
 - 1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 23 05 13.

2.04 END-SUCTION PUMPS

- A. Split-Coupled Pump: Base-mounted, single-stage pump with horizontal shaft and radially- or horizontally-split casing rated for discharge pressures up to 175 psi.
- B. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.
- C. Impeller: Stainless steel, balanced, fully enclosed, keyed to shaft.
- D. Bearings: Oil lubricated roller or ball bearings.
- E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- F. Seal: Mechanical, 225 degrees F maximum continuous duty temperature.
- G. Drive: Flexible coupling with coupling guard.
- H. Baseplate: Cast iron or fabricated steel with integral drain rim.
- I. Electrical:
 - 1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 23 05 13.
 - 2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and pump suction fitting on pump suction, and line sized wafer check valve, shut off valve and flow meter on pump discharge.
- E. Install base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. See Section 03 30 00.
- F. Lubricate pumps before start-up.
- G. Controls: Interface each pump starter or VFD with HVAC controller; see Section 23 09 23.

END OF SECTION

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SECTION 23 31 00 - HVAC DUCTWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ducts.
- B. Flexible ducts to grilles, registers and diffusers.

1.02 RELATED REQUIREMENTS

- A. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
- B. Section 23 33 00 - Air Duct Accessories.
- C. Section 23 36 00 - Air Terminal Units.

1.03 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals.
- B. ASHRAE Std 126 - Method of Testing HVAC Air Ducts.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- D. ICC (IMC) - International Mechanical Code.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- F. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- G. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- H. SMACNA (RIDC) - Rectangular Industrial Duct Construction Standards.
- I. SMACNA (ROUND) - Round Industrial Duct Construction Standards.
- J. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.
- D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.06 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.
- B. Provide metal duct unless otherwise indicated.
- C. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 23 33 19.
- D. Duct Sealing and Leakage in accordance with Static Pressure Class:
- E. Duct Fabrication Requirements:
 - 1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 - 2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 - 3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide turning vanes of perforated metal with glass fiber insulation.
 - 4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
 - 5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - 6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
 - 7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

- A. Material Requirements:

1. Ductwork shall be minimum G-60 coated galvanized steel of lock forming grade conforming to ASTM Standards A-525 and A-527. Duct wall thicknesses, reinforcements, seams, joints, sealing, cross bracing, beading, hangers, supports, etc., shall be in accordance with the latest manual of heating, ventilating and air conditioning duct construction standards as published by the Sheet Metal and Air Conditioning Contractors National Assoc., Inc. (SMACNA).
- B. Pressure Class:
1. All exhaust air, return air, fresh air, transfer air and mixing plenum ductwork shall be 2" pressure class.
 2. All supply air ductwork systems that do not utilize variable air volume boxes shall be 2" pressure class.
 3. All supply air ductwork upstream of variable air volume boxes shall be 6" pressure class.
 4. All supply air ductwork downstream of variable air volume boxes shall be 2" pressure class.
- C. Low and Medium Pressure Round Ductwork:
1. United Sheet Metal Co., Semco Carrier, Linx Industries Lindab Safe, Greater Wisconsin Sheet Metal, Eastern Sheet Metal, Pressure Airduct Corp. Sheet Metal Connectors, or Stamped Fittings, Inc.
 2. Round helically wound lock seam zinc coated steel conduit.
 3. All fittings shall be minimum 20-gauge zinc coated steel.
 4. All 45 deg. elbows shall have a minimum of 3 sections and all 90 deg. elbows shall have a minimum of 5 sections. Smooth long sweep die formed fittings are preferred.
 5. Branch ductwork take-offs shall be accomplished with a 90 deg. shoe tap saddle with an increased area connection.
 6. All elbows shall be distortion free.
 7. All fittings and joints to be joined using United Duct Sealer or Linx Industries Lindab Safe self-sealing system, in accordance with manufacturers recommendations.

2.03 FLEXIBLE DUCTS TO GRILLES, REGISTERS AND DIFFUSERS

- A. Furnish and install flexible ducts where indicated on the drawings.
- B. Flexmaster, Novaflex, Thermaflex, or Buckley flexible ductwork.
- C. Factory applied glass fiber insulation with vaporproof jacket, minimum total insulating value R=6.
- D. The ductwork shall be UL 181 listed, Class 1 Air Duct and comply with NFPA 90A and 90B.
- E. Supply, Return, and Exhaust Ducts:
 1. Flexmaster Type 1, Novaflex Type 8, Thermaflex M-KC, or Buckley Type 3.
 2. Polyethylene fabric core supported by a galvanized steel helix formed and mechanically locked to the liner.

3. Working pressure not less than 10" w.g. positive and 2" w.g. negative.
4. Minimum Acoustic Performance:

	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz
Up to 8 inch dia.	5	10	22	34	22
10 -12 inch dia.	6	27	22	28	18

F. Transfer Ducts:

1. Flexmaster Type 6M, Novaflex Type 6, Thermaflex M-KE, or Buckley Type 4.
2. Acoustical spun bond nylon fabric core supported by a galvanized steel helix formed and mechanically locked to the liner.
3. Working pressure not less than 6" w.g. positive.
4. Minimum Acoustic Performance:

	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz
Up to 8 inch dia.	26	27	27	31	32
10 -12 inch dia.	22	26	24	31	31

PART 3 EXECUTION

3.01 INSTALLATION

- A. Verify dimensions at the site, making field measurements and drawings necessary for fabrication and erection. Check plans showing work of other trades and consult with Engineer in the event of any interference.
- B. Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Transform, divide or offset ducts as required, in accordance with SMACNA, except do not reduce duct to less than six inches in any dimension and do not exceed a 6:1 aspect ratio.
- C. Cut or drill test holes in ducts where indicated or as required. Cap with neoprene plugs.
- D. Provide frames constructed of angles or channels for coils, filters, dampers or other devices installed in duct systems, and make all connections to such equipment, including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts and washers.
- E. For all ductwork upstream of the variable volume air boxes, all indoor transverse joints, longitudinal seams, girth joints, branch intersections, fitting subsections, lower connections, grilles, registers and outlets connections, access door frame connections, etc., are to be sealed in accordance with IECC Seal Class A requirements for all low, medium and high pressure ductwork, utilizing Hardcast Inc. Iron Grip 601 water based UL classified vinyl acrylic duct sealant. Clean all surfaces of dirt, oil and grease before application. Coverage to be approximately 125 square feet per gallon with 20 mil thick wet film. At Contractor's option, duct sealing may be performed utilizing Aero seal duct sealing system in lieu of vinyl acrylic duct sealant.

- F. Seal water tight with G.E. Silicone Construction Sealant all joints within 6" of bottom of all outside air intake ducts and pitch outside air intakes to outside of building.
- G. Seal water tight with G.E. Silicone Construction Sealant all joints within 6" of bottom of all exhaust ductwork from outside termination back to automatic exhaust dampers and/or backdraft dampers.
- H. Furnish and install a drip pan in exhaust and relief ductwork under each roof exhauster and weatherproof hood per plan detail. Seal water tight with G.E. Silicone Construction Sealant all joints in drip pan and all joints within 6" of bottom of drip pan.
- I. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- J. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- K. For flexible ductwork to grilles, registers and diffusers:
 - 1. Flexible duct may be used for final connection to grilles, registers and diffusers where indicated. Where flexible duct is used, it shall be the minimum length required to make the final connections, but no greater than 4 feet in length. Flexible ducts shall be as straight as possible with no more than one 90 deg. elbow.
 - 2. Individual sections of flexible ductwork shall be of one piece construction. Splicing of short sections will not be accepted.
 - 3. Penetration of any partition, wall, or floor with flexible duct will not be accepted.
 - 4. Fittings, couplings, etc., shall be joined by applying a coat of 3M EC-800 or Benjamin Foster 30-02 cement to the joining surfaces. Insert fitting to the bead and secure with a metal draw band. Finally, wrap exposed seam with a 3" wide band of pressure sensitive duct tape.
 - 5. Ducts shall be hung from the building construction with galvanized steel strap hangers.

END OF SECTION

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SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Duct access doors.
- C. Duct test holes.
- D. Flexible duct connectors to air handling equipment.
- E. Volume control dampers.

1.02 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- B. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- D. Project Record Drawings: Record actual locations of access doors and test holes.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 DUCT ACCESS DOORS

- A. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick-fastening locking devices. For insulated ducts, install minimum 1-inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.

2. Up to 18 inches Square: Provide two hinges and two sash locks.
3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.

2.03 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.04 FLEXIBLE DUCT CONNECTORS TO AIR HANDLING EQUIPMENT

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz/sq yd.
- C. Maximum Installed Length: 14 inch.

2.05 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Splitter Dampers:
 1. Material: Same gauge as duct to 24 inches size in either direction, and two gauges heavier for sizes over 24 inches.
 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- C. Single Blade Dampers:
 1. Fabricate for duct sizes up to 6 by 30 inch.
 2. Blade: 24 gauge, 0.0239 inch, minimum.
- D. Multi-Blade Damper: Fabricate consisting of opposed blades with maximum blade sizes 8 by 72 inches. Assemble center- and edge-crimped blades in prime-coated or galvanized-channel frame with suitable hardware.
 1. Blade: 18 gauge, 0.0478 inch, minimum.
- E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 31 00 for duct construction and pressure class.

- B. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch size access door for hand and shoulder access, or as indicated on drawings. Provide minimum 4 by 4 inch size access door for balancing dampers only. Review locations prior to fabrication.
- C. Provide duct test holes where indicated and required for testing and balancing purposes.
- D. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.
- E. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- F. Install air measuring station at locations indicated on the drawings in accordance with manufacturers recommendations.

END OF SECTION

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SECTION 23 34 23 - HVAC FANS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof exhausters.
- B. Inline centrifugal fans.
- C. Utility vent blowers.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 31 00 - HVAC Ductwork.

1.03 REFERENCE STANDARDS

- A. AMCA 99 - Standards Handbook.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 HVAC FANS - GENERAL

- A. Static and Dynamically Balanced: Comply with AMCA 204.
- B. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.
- C. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.
- D. Fabrication: Comply with AMCA 99.
- E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.02 ROOF EXHAUST FANS

- A. Manufacturers:
 - 1. Carnes

2. Greenheck
 3. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
 4. Twin City Fan & Blower: www.tcf.com/#sle.
 5. Cook
 6. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fan Unit: V-belt as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- C. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, insulation and curb bottom.
- D. Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor.
- E. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- F. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.03 INLINE EXHAUST FANS

- A. Manufacturers:
1. Greenheck
 2. Cook
 3. Carnes
 4. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
 5. Twin City Fan & Blower: www.tcf.com/#sle.
 6. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Furnish fans of steel or aluminum construction with universal type mounting bracket, centrifugal fan wheel with ball bearing supports, variable speed EC motor (RF-3, EF-1 and EF-3) and NEMA approved ball bearing motor (RF-1) as indicated, adjustable V-belt drive or direct connected as indicated, adjustable motor base for V-belt drive units, vibration isolators and bearing lubrication tubes.
- C. For all direct drive EC motors, furnish with factory pre-wired potentiometer for balancing.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm gets reached with sheaves set at mid-position; fan shaft with self-aligning prelubricated ball bearings.

2.04 UTILITY EXHAUST FANS

- A. Manufacturers:

1. Greenheck
 2. Cook
 3. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
 4. Carnes
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Furnish fans with forward curved, backwardly inclined centrifugal fan wheel with ball bearing supports, NEMA approved resiliently mounted open ball bearing motor with adjustable motor mount, direct drive, vibration isolation and steel fan housing. Furnish cover over motor and drive, and bonderized prime coat or galvanized finish.
- C. Motorized multi-louver discharge damper with low voltage electric damper operator.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install all fans where indicated on the drawings and in accordance with manufacturers recommendations. Secure roof exhausters with stainless steel lag screws to roof curb.
- C. Roof mounted Centrifugal fans shall be set on Pate, Thy or Vent Products equipment support curbs complete with minimum 18 gauge galvanized steel construction with integral base plate, continuous welded corner seams, factory installed wood nailer, counter flashing with lag screws and built in cant for roof as required.
- D. Utility set exhaust fan EF-2 shall be installed on equipment support rails. Support rails shall be securely fastened to existing structure.
- E. All suspended fans shall be supported from steel supports with suspensions, frames, brackets, braces, etc. Supports shall be constructed to properly support and distribute the load and shall incorporate anti-vibration devices, anti-sway bracing and anchoring plates as required. Supports may be constructed of I-beams, channels, angle iron or threaded steel rods. All permanent supports shall be welded. All threaded rods and bolts shall have nuts welded to rod, threads peened or double nuts.
- F. All floor interior mounted fans shall be set on concrete pads which shall be a minimum of 3 ½" thick unless otherwise indicated. Pads shall be sized for a minimum overlap of 3" on the exterior dimension of the fan base mounted thereon.
- G. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
- H. Provide sheaves required for final air balance.
- I. Install backdraft dampers on inlet to roof exhausters.

END OF SECTION

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SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 23 31 00 - HVAC Ductwork.

1.02 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. AHRI 880 (I-P) - Performance Rating of Air Terminals.
- C. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- E. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
- D. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
- E. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.01 SINGLE-DUCT, VARIABLE-VOLUME UNITS

- A. Manufacturers:
 - 1. Krueger
 - 2. Metalaire
 - 3. Price
- B. General:
 - 1. Factory-assembled, AHRI 880 (I-P) rated, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
 - 2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.
- C. Unit Casing:
 - 1. Minimum 22 gauge, 0.0299 inch galvanized steel.
 - 2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
 - 3. Unit Discharge: Rectangular, with slip-and-drive connections.
 - 4. Acceptable Liners:
 - a. 1/2 inch thick, coated, fibrous-glass complying with ASTM C1071.
 - 1) Secure with adhesive.
 - 2) Coat edges exposed to airstream with NFPA 90A approved sealant.
 - 3) Cover liner with non-porous foil.
 - b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.
- D. Damper Assembly:
 - 1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
 - 2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
 - 3. Incorporate low leak damper blades for tight airflow shutoff.
- E. Hot Water Heating Coil:
 - 1. Coil Casing: Minimum 22 gauge, 0.0299 inch galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.
 - a. Access Door: Gasketed and insulated located on bottom.

2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
3. Coil leak tested to minimum 350 psig.
4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.
5. VAV box selections for shop drawing review shall be made by fixing the design flow rates (gpm) to the scheduled values. Leaving air temperatures shall meet or exceed the scheduled values.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.
- C. Provide ceiling access doors or locate units above easily removable ceiling components.
- D. Support units individually from structure in accordance with SMACNA (SRM).
- E. Do not support from ductwork.
- F. Connect to ductwork in accordance with Section 23 31 00.

3.02 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum zero percent full flow.

3.03 CLEANING

- A. Vacuum clean coils and inside of units.

3.04 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training for additional requirements.

END OF SECTION

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SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets.
- B. SMACNA (ASMM) - Architectural Sheet Metal Manual.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.03 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.
- C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Krueger
- B. Price
- C. Titus

2.02 SQUARE PLAQ CEILING DIFFUSERS

- A. Type: Provide square formed core removable ceiling diffusers constructed to maintain 360 degree discharge air pattern.
- B. Connections: As indicated on drawings.
- C. Frame: Provide inverted T-bar type.
- D. Fabrication: Steel with baked enamel finish.
- E. Color: As selected by Architect from manufacturer's standard range.
- F. Accessories: Provide removable core with damper adjustable from diffuser face.

2.03 CEILING EGG CRATE EXHAUST, RETURN AND TRANSFER GRILLES

- A. Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch grid core.
- B. Fabrication: Grid core consists of aluminum with baked enamel finish.
- C. Color: To be selected by Architect from manufacturer's standard range.
- D. Frame: Grilles for T-bar lay-in installation shall have no flange border. Surface mounted type to have flange type frame with countersunk holes for surface mounting.

2.04 WALL SUPPLY GRILLES

- A. Furnish grilles with adjustable double deflection steel grille core, flanged frame with sponge rubber gasket, horizontal face fins with 3/4" maximum fin spacing and vertical rear fins.
- B. Frame: 1 inch margin with countersunk screw mounting and gasket.
- C. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.

2.05 WALL EXHAUST AND RETURN GRILLES

- A. Furnish registers with steel grille core, flanged frame with sponge rubber gasket, fixed horizontal face fins with a 3/4" maximum fin spacing set in an angular position and a key operated opposed blade volume damper.
- B. Frame: 1 inch margin with countersunk screw mounting.
- C. Color: To be selected by Architect from manufacturer's standard range.

2.06 LOUVERS

- A. See Specification Section 08 91 00 - Louvers

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers and grilles and registers, despite whether dampers are specified as part of diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black.
- G. Where ceiling tiles are cut to accomodate grilles, coordinate with General Contractor the painting of cut edge to match color of ceiling tile.
- H. Install insulated metal panel on unused portion of louver. Panels must be sealed weathertight to louver assembly with flashing as required for proper drainage to outside of building.

3.02 CLOSEOUT ACTIVITIES

- A. Demonstrate operational system to Owner's representative.
- B. Instruct Owner's representative to maintain system and use occupant controls or interfaces, as required.

3.03 PROTECTION

- A. Protect installed products until completion of project.
- B. Replace, repair, or touch-up damaged products before Substantial Completion.

END OF SECTION

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SECTION 23 73 13 - INDOOR AIR-HANDLING UNITS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality.
- C. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks.
- D. NFPA 70 - National Electrical Code.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- F. UL (DIR) - Online Certifications Directory.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 - 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- D. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- E. Manufacturer's Instructions: Include installation instructions.
- F. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Extra Filters: One set for each unit.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.05 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Daikin Applied
- B. Aeon
- C. Trane Technologies
- D. JCI/York
- E. PACE

2.02 REGULATORY REQUIREMENTS

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

2.03 CONSTRUCTION

- A. Furnish sectionalized double wall casing of insulated steel with bonderized paint or galvanized steel finish, base rails and all necessary access panels to service fan bearings, coils and dampers. Complete with insulated waterproofed drain pan. Furnish blank sections as indicated or required to provide service access.
- B. Base rail shall be of sufficient height to raise unit for external trapping of condensate drain pans.
- C. Variable aspect ratio as required to meet dimensional requirements as scheduled.
- D. Provide coils with a maximum fin spacing of 14 fins per inch.
- E. Drainable hot water coil constructed of copper tubes, aluminum fins and 3-way valve (where specified on plans).
- F. Standard single serpentine drainable chilled water coil constructed of copper tubes and aluminum fins as indicated.
- G. Furnish flat arrangement 1" thick low velocity throwaway MERV 8 pre-filters.

- H. Furnish an angle or flat arrangement with 2" thick low velocity throwaway MERV 13 final filters.
- I. Furnish filter draft gauge with 0" to 2" H2O range scale.
- J. Disconnect shall be pre-wired.
- K. Airflow monitoring stations.
- L. Duct mounted smoke detector.

2.04 FAN SECTION (AHU-1)

- A. Air foil, single width, single inlet, centrifugal plug fan, in accordance with AMCA 99.
- B. Where multiple fans are scheduled, provide direct drive fan plenum fan system with variable speed EC motors or VFD rated motors. Provide a VFD for each motor or independent motor controls factory wired to the fan array manufacturer's controller with single point electrical connection
- C. Provide fan array control package with the following minimum controls:
 - 1. Bacnet integration
 - 2. Airflow measurement per fan output to the BAS as a single airflow signal utilizing piezometer rings on each fan inlet with differential pressure transmitters.
 - 3. Alarm of individual fan failure.
 - 4. Operator interface touch screen at the control panel. Individual motor circuit protection.
 - 5. Indicator lights for status of each fan.
- D. Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.
- E. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- F. Bearings: Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with copper tube and grease fitting rigidly attached to casing. Minimum L-10 life of 40,000 hours at maximum rated speed.
- G. Mounting:
 - 1. Individual fan units:
 - a. Locate fan and motor internally on welded steel base coated with corrosion resistant paint.
 - b. Factory mount motor on slide rails.
 - c. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors.
 - d. Provide channel frame for installation of manual blank-off panel. Provide one panel.
- H. Fan Array Units:
 - 1. Mount fan module structural housing and panel assembled within AHU section with blank off panel sealing to casing.
- I. External Motor Junction Box:

1. Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.
- J. Motor Wiring Conduit:
 1. Factory wire fan motor wiring to the unit mounted starter-disconnect, variable frequency drive, and external motor junction box. Provide each motor with a VFD.

2.05 FAN SECTION (AHU-2)

- A. Plenum airfoil centrifugal wheel with ball bearing supports, grease bearing extensions, NEMA approved resiliently mounted open ball bearing motor with adjustable motor mount, direct drive and vibration isolation.
- B. Fan diameter and speed as required such that the setpoint of the variable frequency drive does not exceed 65 Hz to meet the scheduled design parameters.

2.06 COIL SECTION

- A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
- C. Air Coils:
 1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.
- D. Fabrication:
 1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
 2. Fins: Aluminum.
 3. Casing: Die formed channel frame of galvanized steel.
- E. Water Cooling Coils:
 1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install units where indicated on plans.
- C. Units will require disassembly for ingress to the mechanical room. The Mechanical Contractor shall coordinate disassembly and reassembly requirements with the unit manufacturer to ensure that the unit manufacturer's warranty remains intact.

- D. Furnish and install all equipment supports as indicated or required for the installation of units, including miscellaneous upper steel as required to frame into overhead construction for distribution of weight.
- E. Floor mounted units shall be set on concrete pads unless indicated otherwise. Concrete pads shall be a minimum of 3-1/2" thick and shall be sized for a minimum overlap of 3" on the exterior dimension of the unit mounted thereon.
- F. Contractor shall check the plans and verify the proposed unit can be installed in the space allotted and still have adequate room for servicing. All piping and/or duct modifications required for installation of the unit shall be the responsibility of the Mechanical Contractor.
- G. Hot water coils shall be fitted with manual air vent assemblies at the top of each header and for each return bend header. Vent pipes shall extend through the exterior of the unit casing and each shall be complete with manual air vents.
- H. Hot water coils shall be fitted with drain piping at each header and for each return bend header. All drain pipes shall extend through the exterior of the unit casing and shall be fitted with full size drain valves with male hose bibb fitting.
- I. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum 1 inch flex between ductwork and fan while running.
- J. Make connections to coils with unions or flanges.
- K. Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
 - 3. Locate water supply at bottom of supply header and return water connection at top.
 - 4. Provide manual air vents at high points complete with stop valve.
 - 5. Ensure water coils are drainable and provide drain connection at low points.
- L. Cooling Coils:
 - 1. Pipe drain and overflow to nearest floor drain.

3.02 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform systems startup.

3.03 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals for closeout submittals.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance of each component.

- C. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

END OF SECTION

SECTION 23 73 23 - OUTDOOR AIR-HANDLING UNITS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
- C. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality.
- D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks.
- F. NFPA 70 - National Electrical Code.
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- H. UL (DIR) - Online Certifications Directory.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 - 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- D. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- E. Manufacturer's Instructions: Include installation instructions.
- F. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Extra Filters: One set for each unit.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.05 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Daikin Applied
- B. Aeon
- C. Trane Technologies
- D. PACE a brand of Johnson Controls International, PLC[<>]
- E. York, a brand of Johnson Controls International, PLC: www.york.com/#sle.
- F. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 REGULATORY REQUIREMENTS

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

2.03 CONSTRUCTION

- A. Furnish sectionalized weatherproof double wall casing, including unit floor, of insulated steel suitable for roof curb mounting with bonderized paint finish and all necessary access panels to service fan bearings, coils and dampers. Complete with insulated waterproofed drain pan. Furnish blank section as indicated.
- B. Furnish insulated pipe enclosures with roof curb bump-outs and hinged access doors to allow piping to rise up through the roof within the unit curb base. Pipe enclosures shall be the largest size available to maximum internal space for piping insulation, valves, and thermometers, and to facilitate future service and/or valve replacements.
- C. Variable aspect ratio as required to meet dimensional requirements as scheduled.

- D. Provide coils with a maximum fin spacing of 14 fins per inch.
- E. Drainable hot water coil constructed of copper tubes, aluminum fins and 3-way valve (where specified on plans).
- F. Standard single serpentine drainable chilled water coil constructed of copper tubes and aluminum fins as indicated.
- G. Furnish flat arrangement 1" thick low velocity throwaway MERV 8 pre-filters.
- H. Furnish an angle or flat arrangement with 2" thick low velocity throwaway MERV 13 final filters.
- I. Furnish mixing box as indicated with interconnected brass pivoted, opposed blade, fresh air and return air dampers. Damper blades arranged to direct air stream at each other.
- J. Furnish filter draft gauge with 0" to 2" H2O range scale.
- K. Disconnect shall be pre-wired.
- L. Convenience outlet (powered by Electrical Contractor).

2.04 FAN SECTION

- A. Plenum airfoil centrifugal wheel with ball bearing supports, grease bearing extensions, NEMA approved resiliently mounted open ball bearing motor with adjustable motor mount, direct drive and vibration isolation.
- B. Fan diameter and speed as required such that the setpoint of the variable frequency drive does not exceed 65 Hz to meet the scheduled design parameters.

2.05 COIL SECTION

- A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
- C. Eliminators: Three break of galvanized steel, mounted over drain pan.
- D. Air Coils:
 - 1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.
- E. Fabrication:
 - 1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
 - 2. Fins: Aluminum.
 - 3. Casing: Die formed channel frame of galvanized steel.
- F. Water Heating Coils:
 - 1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 - 2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.

G. Water Cooling Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

2.06 FILTER AND AIR CLEANER SECTION

- A. General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.
- B. Differential Pressure Gauge:
1. Provide factory installed dial type differential pressure gauge, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
 2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F.

2.07 DAMPER SECTION

- A. Mixing Section: Provide a functional section to support the damper assembly for modulating the volume of outdoor and return air.
- B. Damper Blades:
1. Double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on each blade.
 2. Self-lubricating stainless steel or synthetic sleeve bearings.
 3. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
 4. Provide leakage testing and pressure ratings in compliance with AMCA 500-D test methods.
 5. Arrange in parallel or opposed-blade configuration.

2.08 ROOF MOUNTING CURB

- A. Roof Mounting Curb: 14 inches high galvanized steel, 2"rigid fiberglass insulation, channel frame with gaskets and nailer strips.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install unit on a supply/return air plenum curb.
- C. Furnish and install all equipment supports as indicated or required for the installation of units, including miscellaneous upper steel as required to frame into overhead construction for distribution of weight.

- D. Contractor shall check the plans and verify the proposed unit can be installed in the space allotted and still have adequate room for servicing. All piping and/or duct modifications required for installation of the unit shall be the responsibility of the Mechanical Contractor.
- E. Hot water coils shall be fitted with manual air vent assemblies at the top of each header and for each return bend header. Vent pipes shall extend through the exterior of the unit casing and each shall be complete with manual air vents.
- F. Hot water coils shall be fitted with drain piping at each header and for each return bend header. All drain pipes shall extend through the exterior of the unit casing and shall be fitted with full size drain valves with male hose bibb fitting.
- G. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum 1 inch flex between ductwork and fan while running.
- H. Make connections to coils with unions or flanges.
- I. Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
 - 3. Locate water supply at bottom of supply header and return water connection at top.
 - 4. Provide manual air vents at high points complete with stop valve.
 - 5. Ensure water coils are drainable and provide drain connection at low points.

3.02 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform systems startup.

3.03 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals for closeout submittals.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance of each component.
- C. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

END OF SECTION

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SECTION 23 74 16 - PACKAGED ROOFTOP AIR-CONDITIONING UNITS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 23 09 15 - DDC Points List
- B. Section 23 09 23 - Direct-Digital Control System for HVAC
- C. Section 23 09 54 - Electric Temperature Control Systems
- D. Section 23 09 93 - Sequence of Operations for HVAC Controls

1.02 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- C. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Extra Filters: One set for each unit.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from physical damage by storing off site until roof mounting curbs are in place and ready for immediate installation of units.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide a five year warranty to include coverage for refrigeration compressors.

PART 2 PRODUCTS

2.01 PACKAGED ROOFTOP AIR-CONDITIONING UNITS

- A. Manufacturers:
 - 1. Valent
 - 2. Trane
 - 3. Aeon
 - 4. Daikin Applied
 - 5. Greenheck
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: Self-contained, packaged, factory assembled and prewired, consisting of steel cabinet with 2" thick insulated double-wall construction, all necessary access panels and fully weatherproof fan rooftop mounting. Unit to be completely factory prewired and shall include a control transformer and space for 3rd party controller, magnetic starter, weatherproof disconnect switch, convenience outlet (powered by Electrical Contractor) and a factory fabricated spring isolation insulated roof mounting curb.
 - 1. Outdoor air filter frames with 2" thick MERV 13 pleated throwaway filters.
 - 2. Outdoor air and return air dampers with modulating damper actuators for automatic operation.
 - 3. Exhaust air damper with 2-position actuator.
 - 4. Outdoor air measuring station.
 - 5. Compressor condensing section shall be complete with copper tube aluminum fin or aluminum microchannel condensing coils, direct drive propeller fans with ECM motors and vertical air discharge with fan guards. The unit shall have at least one modulating digital or variable speed scroll type compressor. Remaining compressors may be standard scroll type. Also furnish magnetic starters, automatic pumpdown control, time delay relays, current demand limiters, timed off cycle, high and low pressure cutouts, crankcase heaters, oil failure switch, full charge of compressor oil and refrigerant and a 5 year compressor warranty.

6. The cooling section shall have direct expansion type cooling coils constructed of copper tubes and aluminum fins, thermostatic expansion valves, liquid line solenoid valves as required and a watertight drain pan.
7. Hail guards for condenser coils.
8. Provide variable frequency drives for supply air and exhaust air fans.
9. Supply fan section shall include a plenum centrifugal fan with ball bearing supports, NEMA approved open ball bearing motor with adjustable motor mount, direct drive.
10. Exhaust air fan section shall include a plenum centrifugal fan with ball bearing supports, NEMA approved open ball bearing motor with adjustable motor mount, direct drive, opposed blade exhaust air dampers suitable for automatic operation.

2.02 OPERATING CONTROLS

- A. Provide terminal strip on unit for connection of third-party operating controls. Terminal strip shall allow for enable/disable of heating and cooling stages and modulation of variable capacity compressor by 23 09 23 contractor.
- B. Provide units with outdoor air damper and return air damper. Furnish all dampers with 2-10VDC modulating actuators. Outdoor air damper shall have fail-closed actuators. Return air damper shall have fail-open actuator. Economizer control shall be decided by logic from 23 09 23 DDC.
- C. Provide unit with 2-position, fail-closed relief air damper.
- D. Provide integral clogged filter switch.
- E. Provide return air duct smoke detector.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Unit roof curb shall be installed per detail. Installation shall include minimum 6 inches of Rockwool insulation and two layers of 5/8" mold resistant gypsum board. All edges, seams, and joints shall be thoroughly sealed with acoustic sealant to eliminate noise penetration through any gaps around pipe risers or duct drops. Install galvanized steel channel all around the curb perimeter and duct drops for support of gypsum board as required. At contractor's option, roof curb may be installed with BRD Hushcore deck system, model HIC-DS-52.
- C. The Mechanical Contractor shall provide photo documentation of the roof curb sound control system installation to the Engineer for records and to verify compliance with the specifications and details, and also retain copies for his own records.
- D. Provide loop seal per detail at each cooling coil drain pan connection.

3.02 SYSTEM STARTUP

- A. Prepare and start equipment. Adjust for proper operation.

END OF SECTION

SECTION 23 81 26 - SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air cooled condensing units.
- B. Indoor air handling (fan and coil) units for ducted systems.
- C. Controls.

1.02 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems.
- D. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units.
- E. NEMA MG 00001 - Motors and Generators.
- F. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
- D. Design Data: Indicate refrigerant pipe sizing.
- E. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.04 QUALITY ASSURANCE

1.05 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carrier Corporation: www.carrier.com/#sle.
- B. Rheem Manufacturing Company Inc: www.rheem.com/#sle.
- C. Trane Technologies, PLC: www.trane.com/#sle.

- D. York International Corporation / Johnson Controls: www.york.com/#sle.
- E. Daikin.
- F. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Heating: Natural gas fired.
 - 2. Cooling: Outdoor electric condensing unit with evaporator coil in central ducted indoor unit.
 - 3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- B. Performance Requirements: See Drawings for additional requirements.

2.03 INDOOR AIR HANDLING UNITS FOR DUCTED SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.
 - 1. Air Flow Configuration: Horizontal.
 - 2. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
- B. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.
 - 1. Motor: NEMA MG 1; 1750 rpm multiple speed, permanently lubricated, hinge mounted.
- C. Air Filters: 1 inch thick glass fiber, disposable type arranged for easy replacement.
- D. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 - 2. Manufacturers: System manufacturer.

2.04 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 - 1. Refrigerant: R-454B or R-32.
 - 2. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
 - 3. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.

- B. Compressor: Hermetic, two speed 1800 and 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high-pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
- C. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
 - 1. Condenser Fans: Direct-drive propeller type.
- D. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
 - 1. Provide thermostatic expansion valves.
- E. Operating Controls:
 - 1. Control by room thermostat to maintain room temperature setting.

2.05 ACCESSORY EQUIPMENT

- A. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
 - 1. Automatic switching from heating to cooling.
 - 2. Thermostat Display:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. System Mode Indication: Heating, Cooling, Fan Auto, Off, and On, Auto or On, Off.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.
- C. Verify that proper fuel supply is available for connection.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION

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SECTION 23 82 00 - CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic finned tube radiation.
- B. Hydronic unit heaters.
- C. Fan-coil units.
- D. Blower-coil units.

1.02 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. AHRI 440 - Performance Rating of Room Fan-Coils.
- C. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
- D. NFPA 70 - National Electrical Code.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.03 ADMINISTRATIVE REQUIREMENTS

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:

PART 2 PRODUCTS

2.01 HYDRONIC FINNED TUBE RADIATION

- A. Manufacturers:
 - 1. Sterling
 - 2. Rittling
 - 3. Vulcan
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Heating elements to be constructed as indicated on schedule and of lengths as shown on plans. Lengths may not be varied unless approved by the Engineer in writing. Capacities may not be less than that indicated on the plans.
- C. Sloping top discharge with open bottom.
- D. Units to have end trim strips at all wall terminations and end caps at all other cabinet terminations.
- E. Furnish access panels for access to valves and traps consisting of 2 ft. long removable enclosure section.

- F. Finish: Factory applied baked enamel of color selected by Architect.

2.02 HYDRONIC UNIT HEATERS

- A. Manufacturers:
1. Sterling
 2. Rittling
 3. Vulcan
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Furnish units with direct driven propeller fan, hot water coil constructed of copper tubes and aluminum fins and totally enclosed resiliently mounted motor of speed indicated.
- C. Perform factory run test under normal operating conditions, water, and steam flow rates.
- D. Minimum 18 gauge, 0.0478 inch thick sheet steel casing with threaded pipe connections for hanger rods.
- E. Finish: Factory applied baked enamel.
- F. Air Outlet: Adjustable horizontal discharge louvers and safety fan guard.

2.03 FAN-COIL UNITS

- A. Manufacturers:
1. Daikin
 2. Aeon
 3. Trane
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Performance Data and Safety Requirements:
1. Unit capacities certified in accordance with AHRI 440.
 2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL) as suitable for purpose indicated.
 3. Insulation to comply with NFPA 90A requirements for flame spread and smoke generation.
 4. Equipment wiring to comply with requirements of NFPA 70.
- C. Required Directory Listings: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
- D. Horizontal Recessed Units:
1. Provide with a galvanized steel cabinet, easily removed panels, glass fiber insulation, with minimum 18 gauge, 0.0478 inch thick sheet steel bottom panel.
 2. Ducted Units: Provide with air inlet and outlet duct collars.
 3. Forward curved centrifugal fan with direct connected variable speed EC motor for control by BAS with built-in overload protection, access door flush mounted.
 4. Furnish with MERV 13 throwaway filters.

5. Furnish copper tube, aluminum fin four pipe two coil module as indicated. (Cooling coil shall be first in air stream).
6. Furnish insulated condensate drain pan on cooling units complete with prewired condensate overflow switch and fan interlock.
7. Cabinet to be baked enamel finish of manufacturers standard color as selected by Architect.

2.04 BLOWER-COIL UNITS

- A. Manufacturers:
 1. Daikin
 2. Aeon
 3. Trane
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Performance Data and Safety Requirements:
 1. Coils rated and tested in accordance with AHRI 410.
 2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL) as suitable for purpose indicated.
 3. Comply with NFPA 90A for unit construction, including filters and related equipment, for protection of life and property from fire, smoke, and gases resulting from conditions having manifestations similar to fire.
- C. Construction:
 1. Furnish unit with forward curved centrifugal fan with variable speed EC motor for control by BAS with built-in overload protection and access door.
 2. Furnish with two-inch thick, MERV 13 throwaway filters.
 3. Furnish copper tube, aluminum fin four pipe two coil module as indicated. (Cooling coil shall be first in air stream).
 4. Furnish insulated condensate drain pan complete with prewired condensate overflow switch and fan interlock.
 5. Cabinet to be 18 gauge insulated steel casing with baked enamel finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.

3.02 PREPARATION

3.03 INSTALLATION

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

- B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C. Do not damage equipment or finishes.
- D. Finned Tube Radiation:
 - 1. Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated.
 - 2. Center elements under window with elements of equal length centered under each window for multiple windows.
 - 3. Install wall angles and end caps where units butt against walls.
 - 4. Align cabinet joints with window mullions.
 - 5. Install wall angles where units butt against walls and align cabinet joints with window mullions.
- E. Unit Heaters:
 - 1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
 - 2. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- F. Fan-Coil Units:
 - 1. Install as indicated.
 - 2. Coordinate to ensure correct recess size for recessed units.
- G. Units with Hydronic Coils:
 - 1. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping.
- H. Units with Cooling Coils:
 - 1. Connect drain pan to condensate drain.
- I. Blower-Coil Units:
 - 1. Verify all surfaces and openings at unit location can suitably accommodate unit(s).
 - 2. Install in accordance with manufacturer's recommendations.
 - 3. Provide manual shut-off valve on hydronic supply side of coil and balancing valve with memory stop on return side.

3.04 CLEANING

- A. After construction and painting is completed, clean exposed surfaces of units.
- B. Vacuum clean coils and inside of units.
- C. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
- D. Install new filters.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals for closeout submittals.

- B. See Section 01 79 00 - Demonstration and Training for additional requirements.

3.06 PROTECTION

- A. Provide finished cabinet units with protective covers during the balance of construction.

END OF SECTION

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the work of this Contractor.
- B. This Division Contractor shall review the entire set of documents, including other Division Contract Documents as there may be additional requirements for other trades which pertain to this Division Contractor's work, and thus those additional requirements are hereby made a part of these Specifications and Drawings.
- C. All Division 26, 27 and 28 Specifications, Electrical Drawings and Technology Drawings relate and apply to each other as applicable and fall under the requirements of this Section.
- D. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract.

1.02 CODES AND PERMITS

- A. Perform all work in accordance with all state, local and municipal electrical codes, ordinances and Authorities Having Jurisdiction.
- B. Submit required paperwork for permits and inspections and pay all associated fees.

1.03 DRAWINGS

- A. The Contractor shall be responsible for providing and constructing complete and fully functional systems and to adjust work to meet the requirements of all local codes, ordinances and AHJ requirements, applicable industry standards and manufacturers' requirements, while meeting the intent/design of the contract documents.
 - 1. The Contractor acknowledges and understands that the drawings are two-dimensional representations of three-dimensional objects.
 - 2. Drawings may be based on imperfect or assumed data, code interpretations and may include unforeseen conflicts and items requiring field coordination.
 - 3. Drawings are diagrammatic and do not show all accessories and equipment necessary for complete and fully functional systems.
 - 4. While the sizes and locations, of design-basis equipment, may be indicated, the Contractor shall properly make all adjustments to meet conditions as they actually exist on the premises.
 - 5. Adjustments that influence the design/intent of the documents shall be approved by the Architect/Engineer.
 - 6. Contractor shall coordinate and provide all changes required at no additional cost.

7. The Contractor shall make such changes at his expense, including changes required to other Contractors' work.
- B. Should equipment, which Contractor proposes to install, require other space conditions, other utility service, or other structural support than those indicated on the drawings, the Contractor shall arrange for such changes with other affected Contractors and with the Architect.
 1. Required changes shall be noted on the submittal cover sheet.
 2. The Contractor shall make such changes at his expense, included changes required to other Contractors' work.
- C. All sizes as given are minimum except as noted.
- D. Equipment and devices shall provide adequate clearance as determined by applicable codes and manufacturers' instructions for entry, servicing and maintenance.
- E. Adjustments shall be discussed with the Engineer with the view to convenience of operation and noninterference with other work.
 1. The Engineer reserves the right to change the location of any conduit, device or piece of equipment to suit conditions, with no added cost to the Owner or the Project Contingency if the requested change does not modify the scope of work.

1.04 CONFLICTING INFORMATION

- A. Where conflicting information occurs within the contract documents or between the contract documents and any codes, ordinances, industry standards or authorities having jurisdiction, it shall be brought to the attention of the Engineer prior to bidding.
- B. If a conflict cannot be clarified or resolved prior to the bid date, the Contractor shall bid the most expensive option that meets the intent and shall provide a deduct, during construction, if Engineer allows the less costly option.

1.05 WORK SEQUENCE AND SCHEDULING

- A. Refer to Division 01 for construction phasing requirements.

1.06 SUBMITTALS

- A. The requirements listed below are in addition to the Section 01 30 00 - Administrative Requirements. See the individual technical sections for items requiring submittals.
- B. Submit complete manufacturers' product data, dimensioned shop drawings field test reports and, where required, floorplan layouts and system riser diagrams.
 1. Contractors shall provide submittals to Engineer in a timely manner, well before ordering of equipment is necessary, as to not require an expedited review.
 2. Incomplete submittals or those that do not meet all the requirements will be returned to the Contractor un-reviewed.
 3. No time extensions or cost increases will be allowed for delays caused by returned, rejected, noted or incomplete submittals.

4. Submittal review by Architect or Engineer is for general conformance only and does not relieve Contractor of responsibility to fulfill all specifications and requirements of the Contract Documents.
5. Clearly mark general catalog sheets and drawings to indicate the specific items being submitted and with proper identification of equipment by name and/or number, as indicated in the Contract Documents. Failure to do this will result in the submittal(s) being rejected and returned to the Contractor for correction and resubmission.
6. The Contractor shall coordinate all overcurrent protection requirements for equipment provided by other Division Contractors prior to submitting the switchgear to the A/E. If it is found during construction that different overcurrent protection and associated components are required, this Division Contractor shall correct the deficiency at no cost to the Owner or Architect/Engineer.

C. Electronic Submittals

1. All electronic submittals shall utilize the Portable Document File (PDF) format.
2. All submittals shall be original PDFs marked up and merged within PDF markup and authoring software. It shall be unacceptable to submit scanned documents.
3. All files shall be fully searchable using the PDF reader "find" functionality.
4. Files that contain data for more than one device or piece of equipment shall utilize the bookmark functionality.
 - a. Bookmarks shall allow the reviewer to jump directly to each submitted piece of equipment, without scrolling through the document.
 - b. Bookmarked items shall be labeled to correspond with the nomenclature or symbol used in the construction documents.
5. The nomenclature or symbology used on the drawings and specifications shall be clearly marked on the submittal page for that item.
6. It shall be clear what options, accessories or equipment are being provided.
7. Engineer will only review information contained within product cutsheets and prepared shop drawings. Part numbers contained within bills of materials or in other locations, will not be reviewed or verified to match product cutsheets or prepared shop drawings.

1.07 WORK BY OTHER TRADES

- A. Electrical information in the Drawings and Specifications for equipment to be provided by other Division Contractors is based on preliminary design data only. This Contractor shall lay out the electrical work and shall be responsible for its correctness to match equipment actually provided by others. The Division 26, 27 and 28 Contractor shall not rough-in any work prior to completing this coordination with other Division Contractors.

1.08 OPERATIONS AND MAINTENANCE MANUALS

- A. Operation and Maintenance Manuals shall include the following information for all devices, systems and equipment:
 - 1. Standard operating instructions.
 - 2. Complete repair parts lists
 - 3. Summary of maintenance procedures required monthly, yearly, etc. for all equipment. If none are required, this shall be noted.
 - 4. Copies of approved submittals.
 - 5. Warranty information for all equipment, systems and devices.
 - 6. See Division 01 for additional requirements.
- B. Electronic versions of Operations and Maintenance Manuals shall also conform to the following requirements:
 - 1. All electronic Operations and Maintenance Manuals shall utilize the Portable Document File (PDF) format.
 - 2. All submittals shall be original PDFs marked up and merged within PDF markup and authoring software. It shall be unacceptable to submit scanned documents.
 - 3. All files shall be fully searchable using the PDF reader "find" functionality.
 - 4. All electronic files shall utilize PDF bookmark functionality.
 - a. Bookmarks shall allow the reviewer to jump directly to each submitted piece of equipment, without scrolling through the document.
 - b. Bookmarks shall be organized based on specification section and labeled to correspond with the nomenclature used on the actual equipment identification and as built drawings.
 - 5. It shall be clear what options, accessories or equipment were provided
 - 6. These requirements are in addition to Division 01 requirements. See Division 01 for additional requirements.

1.09 RECORD DRAWINGS

- A. The Contractor shall maintain at least one copy each of the specifications and drawings on the job site, at all times.
- B. At completion of the project, the Contractor shall submit the marked-up record drawings to the Architect/Engineer prior to final payment.

PART 2 PRODUCTS

2.01 QUALITY REQUIREMENTS

- A. Items indicated on the drawings and in the specifications, are listed by manufacturer, in order to describe minimum quality requirements.

- B. All materials and equipment furnished shall be new and shall be the standard products of manufacturers regularly engaged in the production of Electrical materials and equipment.
- C. All products shall be warranted as required by these specifications, regardless of manufacturer's standard warranty terms.
 - 1. Where items are required to have warranty terms beyond the standard manufacturer's warranty, an extended warranty, which meets or exceeds these requirements shall be provided at no additional cost.
 - 2. Where the factory will not warrant the item, per this specification, the Contractor shall provide the warranty service and replacement, per specifications.
 - 3. Where no warranty requirements are provided in the specifications, the manufacturer's warranty terms of the basis of design product shall be applied to equals provided.
- D. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If the product is comprised of subassemblies, the complete assembled product shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, subject to approval of the Owner, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled.
- E. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
 - 1. Underwriters Laboratories Inc.
 - 2. Electrical Testing Laboratories, Inc.

2.02 SEALING AND FIRE STOPPING

- A. Refer to Section 07 84 00 - Firestopping for material requirements.
- B. In interior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with the manufacturer's instructions.
- C. Fire rated putty rated to maintain the fire rating of the respective wall, floor or ceiling.

2.03 ACCESS PANELS

- A. Refer to Section 08 31 00 - Access Doors and Panels for material requirements.

PART 3 EXECUTION

3.01 INSTALLATION STANDARDS

- A. All work included in the Division 26, 27 and 28 sections shall be performed in accordance with the National Electrical Installation Standards, NEMA, UL and the currently adopted National Electrical Code.

3.02 WORK PRIORITY AND COORDINATION

- A. Coordinate arrangement, clearances and installation sequence, prior to installation, with all other Contractors to ensure:
1. Proper clearance per applicable codes.
 2. Proper clearance for maintenance and operation per manufacturer.
 3. Future expansion capability where specified.
 4. Layout of lighting fixtures as shown on plans.
 5. Proper layout of other devices with code-required spacing or location.
 6. The Contractor shall cooperate with other trades and Owner's personnel in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the Owner. The Contractor shall check location of electrical outlets with respect to other installations before installing.
 7. Coordination of chases, slots, inserts, sleeves, and openings with general construction work and arrange.
 8. Electrical, Systems or Technology provisions required for other Contractor's equipment, whether shown or not in the construction documents.
 9. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces or, otherwise, made inaccessible by other equipment or surfaces.
 10. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
 11. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.
 12. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in or on architectural surfaces.
 13. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.
 14. Provide coordination drawings to the A/E for areas of work of sufficient density. Contractor to review the Drawings and Project Manual prior to the start of construction to identify areas that require coordination drawings.
- B. PROJECT CONDITIONS
1. The Electrical Contractor shall review the conduit system and shall notify the Consultant, the Architect and the Electrical Engineer of any deficiencies or inadequacies in the conduit system design prior to submitting a bid.

2. The Electrical Contractor shall visit the site and/or review the Architectural Drawings prior to submitting a bid. No allowance or claim for additional services or fees will be allowed for failing to observe or verify conditions that may affect the installation.

3.03 REMODEL WORK

- A. Wherever remodeling work or demolition of existing equipment, light fixtures, conduit, etc. is a part of plans and specifications, Contractor shall visit the site and thoroughly examine all existing conditions.
 1. Provide all required work necessary for interconnection of existing services with new system and removal of existing unused components.
 2. Provide all required work necessary for reconnection of existing services disrupted by remodeling or demolition.
- B. Contractors shall notify the Architect at least 10 days prior to the bid closing date of any deviations or required changes that are noticed based on existing conditions
 1. No allowance for additional costs for work related to existing conditions will be permitted after bidding unless proof of hidden work, breakage or damage could not be determined by inspection or examination by the Contractor.

3.04 DEMOLITION

- A. Coordinate requirements of Demolition with Division 02 requirements.
- B. Wherever demolition of existing equipment, light fixtures, conduit, etc. is a part of plans and specifications, Contractor shall visit the site and thoroughly examine all existing conditions.
 1. Provide all required work necessary for reconnection of existing services disrupted by demolition.
 2. Protect existing electrical equipment and installations indicated to remain.
 3. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- C. Accessible Work:
 1. Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- D. Abandoned Work:
 1. Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction.
 2. Cap raceways and patch surface to match existing finish.
- E. Demolished Items
 1. Remove demolished material from Project site.
 2. Arrange with Owner to retain the following demolished equipment or material for spare stock or use in future projects.

a. _____

F. Relocated Items

1. Remove, store, repair, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.05 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations.
1. All cutting, repair and refinishing shall be performed by skilled tradespeople to the standards called out in the pertinent sections.
 2. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces.
 3. Install new fireproofing where existing fireproofing has been disturbed.

3.06 FINISHING AND TOUCHUP 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.
- B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780 and Division 09.

3.07 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
1. Electrical demolition.
 2. Cutting and patching for electrical construction.
 3. Touchup painting.

3.08 INSERTS AND SLEEVES

- A. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used.
1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
 2. Coordinate with precast supplier, prior to fabrication, to provide inserts, sleeves, openings, boxes and conduit required.
 3. Provide required grounding connections and pigtails to structural and slab steel prior to concrete installation.
 4. Coordinate with precast supplier, prior to fabrication to provide access to steel reinforcement as required for grounding.

- B. Install sleeves for cable and raceway penetrations of masonry, fire and sound rated gypsum walls and of all other fire and sound rated floor and wall assemblies.
- C. In wet area floor penetrations, top of sleeve to be 2 inches above the adjacent floor. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to the existing floor structure. Wet areas for this paragraph are rooms or spaces containing air handling unit coils, converters, pumps, chillers, boilers, and similar waterside equipment.

3.09 SEALING AND FIRE STOPPING

- A. Refer to Section 07 84 00 - Firestopping for installation requirements.
- B. Apply firestopping to cable and raceway penetrations of fire-rated and sound-rated floor and wall assemblies to achieve fire-resistance and sound rating of the assembly.

3.10 ACCESS PANELS

- A. Refer to Section 08 31 00 - Access Doors and Panels for installation requirements.
- B. Provide access panels to allow access to all junction boxes behind sheet rock and plaster walls and ceilings.

3.11 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill work to accomplish indicated electrical systems installation in accordance with Division 31 - Earthwork. Blasting will not be allowed without written permission of the Architect/ Engineer and the Owner.

3.12 CONCRETE WORK

- A. All cast-in-place concrete related to electrical work (including but not limited to exterior light standards, flood/spot light pole bases, emergency telephone stanchion bases, interior housekeeping pads, exterior service transformer pads, etc.) will be the responsibility of the respective Division 26, 27 and 28 Contractor unless noted otherwise. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for the support of electrical equipment. Refer to Division 03 for additional requirements.

3.13 HOUSEKEEPING PADS

- A. Provide nominal 4inch high concrete housekeeping pads for switchboards and transformers installed on floors at or below grade. Dimension of housekeeping pad shall be 2 inches greater than outside dimensions of equipment on the pad. Coordinate housekeeping pad size with equipment shop drawings. Install 6x6-W4.0/W4.0 wire mesh two inches from the top of the pad. Refer to Division 03 for additional requirements.

3.14 HOUSEKEEPING AND CLEAN UP

- A. This Contractor shall remove debris caused by his operations at the end of each day. On completion, he shall remove all debris from his work and leave same neat and clean, ready for use by the Owner.

3.15 CLEANING AND PROTECTION OF MATERIALS AND EQUIPMENT

- A. This Contractor shall be responsible for all damage caused directly or indirectly by subcontractors and employees.
 - 1. Protect materials, equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury.
 - 3. Any equipment or material damaged shall be removed from the site immediately and replaced at the cost of the Contractor.
 - 4. Any equipment or material exposed to conditions that it is not designed for, shall be removed from the site immediately and replaced at the cost of the Contractor.
- B. At the completion of all work, the equipment shall be thoroughly cleaned and delivered to the Owner in a condition satisfactory to the Engineer. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- C. Equipment used during construction shall be returned to the original condition, which may include such items as replacing light engines, cleaning lenses and replacing damaged devices.

3.16 INSTRUCTIONS

- A. The Contractor shall review with the Owner's representative complete operating and maintenance procedures for equipment and systems installed under this contract. Provide _____ hours of instruction during normal working hours when systems are fully operational and before final payment.

3.17 REQUEST FOR FINAL PUNCH

- A. In addition to the requirements of Section 01 70 00 - Execution and Closeout Requirements, the following items shall be completed and submitted to the A/E prior to the request for the A/E's final punch:
 - 1. All comments requiring follow up in project observations completed.
 - 2. All submittals have been reviewed by the A/E as positive, with no outstanding issues.
 - 3. Final inspection by electrical inspector complete. Copy A/E on inspection report signed by electrical inspector.

4. Letter from the contractor stating that all work is complete and ready for final punch.

END OF SECTION

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SECTION 26 05 05 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

1.02 RELATED REQUIREMENTS

- A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated prior to starting remodel work.
- B. Verify that wiring and equipment that appear to be abandoned are in fact abandoned. Review and confirm with Owner prior to starting demolition.
- C. Demolition drawings are based on casual field observation.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means Contractor accepts existing conditions.

3.02 PREPARATION

- A. Protect areas adjacent to work area from demolition dust and debris.
- B. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- C. Coordinate utility service outages with utility company.
- D. Provide temporary wiring and connections to maintain existing systems in service during construction.
- E. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- F. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain written permission from Owner at least 7 days before partially or completely disabling system.

2. Notify utility company at least 24 hours before partially or completely disabling system
3. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
 2. PCB- and DEHP-containing lighting ballasts.
 3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Where demolition work impacts the support of existing conduits, junction boxes, and systems cables, etc., resupport items per the appropriate specification section(s) and codes.
- D. Remove abandoned wiring to source of supply unless noted otherwise on the drawings.
- E. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- F. Remove abandoned systems cables.
- G. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- H. Disconnect and remove abandoned panelboards and distribution equipment.
- I. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- J. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- K. Repair adjacent construction and finishes damaged during demolition and extension work.
- L. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- M. Extend existing installations using materials and methods as required by other specification sections.
- N. Return removed items to the Owner where noted on the Drawings. Coordinate the return location and timing with the Owner.
- O. Remove demolished material from the project site.

3.04 CLEANING AND REPAIR

- A. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

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SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Metal-clad cable.
- C. Variable-frequency drive cable.
- D. Wiring connectors.
- E. Electrical tape.
- F. Heat shrink tubing.
- G. Wire pulling lubricant.
- H. Cable ties.
- I. Firestop sleeves.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 09 23 - Digital Modular Lighting Controls: Requirements for digital modular lighting controls cabling.
- F. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conductors.
- G. Section 28 46 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes.
- G. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation).
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- I. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable.
- J. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- K. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems.
- L. NFPA 70 - National Electrical Code.
- M. NFPA 79 - Electrical Standard for Industrial Machinery.
- N. UL 44 - Thermoset-Insulated Wires and Cables.
- O. UL 83 - Thermoplastic-Insulated Wires and Cables.
- P. UL 267 - Outline of Investigation for Wire-Pulling Compounds.
- Q. UL 486A-486B - Wire Connectors.
- R. UL 486C - Splicing Wire Connectors.
- S. UL 486D - Sealed Wire Connector Systems.
- T. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
- U. UL 1569 - Metal-Clad Cables.
- V. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Field Quality Control Test Reports.

- D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is not permitted.
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.

- G. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
- H. Manufactured wiring systems are not permitted.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Provide new conductors and cables manufactured not more than one year prior to installation.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Comply with FS A-A-59544 where applicable.
- G. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- H. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- I. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- J. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.
- K. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- L. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- M. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.

2. Control Circuits: 14 AWG.
- N. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- O. Conductor Color Coding:
 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
 - e. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. General Cable Technologies Corporation: www.generalcable.com/#sle.
 - d. Service Wire Co: www.servicewire.com/#sle.
 - e. Southwire Company: www.southwire.com/#sle.
- B. Description: Single conductor insulated wire.

- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 14 AWG and Smaller: Solid.
 - b. Size 10 AWG and Smaller: Solid or Stranded.
 - 1) If Stranded conductors are proposed the Contractor shall ensure that all wiring device terminations are UL listed for use with Stranded conductors, or use a crimp-on Stranded to Solid connector.
 - c. Size 8 AWG and Larger: Stranded.
 - 2. Control Circuits: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.
 - b. Output of VFDs: Type XHHW-2.
 - c. Installed Underground: Type XHHW-2.
 - d. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.04 METAL-CLAD CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 - 2. Encore Wire Corporation: www.encorewire.com/#sle.
 - 3. Service Wire Co: www.servicewire.com/#sle.
 - 4. Southwire Company: www.southwire.com/#sle.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- F. Provide oversized neutral conductors where indicated.
- G. Provide dedicated neutral conductor for each phase conductor.
- H. Grounding: Full-size integral equipment grounding conductor.
 - 1. Provide additional isolated/insulated grounding conductor where indicated.
- I. Armor: Aluminum or steel, interlocked tape.

- J. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.05 VARIABLE-FREQUENCY DRIVE CABLE

- A. Manufacturers:
 - 1. Service Wire Co; ServiceDrive: www.servicewire.com/#sle.
 - 2. Belden: www.belden.com
 - 3. Southwire Company[<>]: www.southwire.com/#sle.
- B. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.
- C. Conductor Stranding: Stranded.
- D. Insulation Voltage Rating: 1000 V.
- E. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.
- F. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.
- G. Provide metallic shielding.
- H. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.06 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.

4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
6. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
7. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilSCO.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilSCO.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilSCO.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.

2.07 ACCESSORIES

- A. Electrical Tape:
 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.

- b. Plymouth Rubber Europa: www.plymouthrubber.com/#sle.
- 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
- 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
- 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
- 6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Wire Pulling Lubricant:
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. American Polywater Corporation: www.polywater.com/#sle.
 - c. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - 2. Listed and labeled as complying with UL 267.
 - 3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 - 4. Suitable for use at installation temperature.
- D. Cable Ties: Material and tensile strength rating suitable for application. Plenum rated if installed above suspended ceilings that are return air plenums.
- E. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.
 - 1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
- F. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
- G. Fire-Protective Coating for Electrical Conductors and Cables: Field-applied, intumescent or ablative coating designed to prevent ignition and propagation of fire along thermoplastic-insulated conductors and cables.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 2. When circuit destination is indicated without specific routing, determine exact routing required.
 3. Arrange circuiting to minimize splices.
 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 7. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
 8. Provide oversized neutral/grounded conductors where indicated and as specified below.
 - a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
 - b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.
- B. Install products in accordance with manufacturer's instructions.

- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install metal-clad cable (Type MC) in accordance with NECA 120.
- E. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from roof decking, raceways, piping, ductwork, or other systems.
 - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
 - 2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- H. Terminate cables using suitable fittings.
 - 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 - c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.
- I. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.
- J. Install conductors with a minimum of 6 inches of slack at each outlet.
- K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

- N. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 - 3. Wet Locations: Use heat shrink tubing.
- P. Insulate ends of spare conductors using wire connectors.
- Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- R. Identify conductors and cables in accordance with Section 26 05 53.
- S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- T. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.

- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing.
Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 27 10 00 - Structured Cabling: Additional grounding and bonding requirements for systems.

1.03 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems.
- D. NFPA 70 - National Electrical Code.
- E. UL 467 - Grounding and Bonding Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Field quality control test reports.

- D. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
 - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- F. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
- G. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
8. Provide bonding for interior metal air ducts.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
 2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gauge of specified conductors.
- C. Connectors for Grounding and Bonding:
 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
4. Manufacturers - Mechanical and Compression Connectors:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Burndy LLC: www.burndy.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.
 - d. nVent ERICO: www.nvent.com/#sle.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. nVent ERICO; Cadweld: www.nvent.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Make grounding and bonding connections using specified connectors.
 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

- D. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

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SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- B. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- C. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. MFMA-4 - Metal Framing Standards Publication.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
 - 4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 30 00.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

1.06 QUALITY ASSURANCE

- A. Maintain at project site one copy of each referenced document that prescribes execution requirements.
- B. Installer Qualifications for Field Welding: See Section 05 50 00.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Applicable building code.
 - c. Requirements of authorities having jurisdiction.
 - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
 - 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported plus minimum 100% factor of safety. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.

- b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Materials for Metal Fabricated Supports: See Section 05 50 00.
- C. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
 - 3. Push-type or push-in type conduit hangers and brackets shall not be used.
- D. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
- E. Metal Channel/Strut Framing Systems:
 - 1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 - 2. Comply with MFMA-4.
 - 3. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent.
 - 4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 - 5. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.
- F. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch diameter.
 - b. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - c. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
 - e. Outlet Boxes: 1/4-inch diameter.
 - f. Luminaires: 1/4-inch diameter.
- G. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
 - 1. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
 - 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.

4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

H. Anchors and Fasteners:

1. Manufacturers - Mechanical Anchors:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
2. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
3. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
4. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
5. Hollow Masonry: Use toggle bolts.
6. Hollow Stud Walls: Use toggle bolts.
7. Steel: Use beam clamps or machine bolts.
8. Sheet Metal: Use sheet metal screws.
9. Plastic and lead anchors are not permitted.
10. Powder-actuated fasteners are not permitted.
11. Hammer-driven anchors and fasteners are not permitted.
12. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel, stainless steel, or approved equivalent .
 - d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

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

- B. Install hangers and supports in accordance with NECA 1.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 - 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized concrete pad 4 inches in height; see Section 03 30 00.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Conduit Support and Attachment: See Section 26 05 33.13 for additional requirements.
- J. Box Support and Attachment: See Section 26 05 33.16 for additional requirements.
- K. Interior Luminaire Support and Attachment: See Section 26 51 00 for additional requirements.
- L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- M. Secure fasteners in accordance with manufacturer's recommended torque settings.
- N. Remove temporary supports.
- O. Identify independent electrical component support wires above accessible ceilings, where permitted, with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 05 33.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Galvanized steel intermediate metal conduit (IMC).
- C. PVC-coated galvanized steel rigid metal conduit (RMC).
- D. Flexible metal conduit (FMC).
- E. Liquidtight flexible metal conduit (LFMC).
- F. Galvanized steel electrical metallic tubing (EMT).
- G. Aluminum electrical metallic tubing (EMT).
- H. Electrical nonmetallic tubing (ENT).

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 27 05 33.13 - Conduit for Communications Systems.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- H. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit.
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- J. NEMA BI 50058 - Electrical Nonmetallic Tubing (ENT).
- K. NFPA 70 - National Electrical Code.
- L. UL 1 - Flexible Metal Conduit.
- M. UL 6 - Electrical Rigid Metal Conduit-Steel.

- N. UL 360 - Liquid-Tight Flexible Metal Conduit.
- O. UL 514B - Conduit, Tubing, and Cable Fittings.
- P. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- Q. UL 797 - Electrical Metallic Tubing-Steel.
- R. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel.
- S. UL 1242 - Electrical Intermediate Metal Conduit-Steel.
- T. UL 1653 - Electrical Nonmetallic Tubing.
- U. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
 - 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

1.06 QUALITY ASSURANCE

- A. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions and shop drawings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Concealed Within Masonry Walls: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- D. Concealed Within Hollow Stud Walls: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- E. Concealed Above Accessible Ceilings: Use galvanized steel electrical metallic tubing (EMT) or aluminum electrical metallic tubing (EMT).
- F. Interior, Damp or Wet Locations: Use PVC-coated galvanized steel rigid metal conduit (RMC).
- G. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).
- H. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC).
 - 1. Locations subject to physical damage include, but are not limited to:
 - a. Loading docks, where exposed below 8 feet.
- I. Exposed, Exterior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).
- J. Exposed, Exterior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC).
 - 1. Exterior locations subject to severe physical damage include, but are not limited to:
 - a. Where exposed to vehicular traffic below 8 feet.
- K. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
 - 1. Maximum Length: 6 feet.
- L. Flexible Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit (FMC).
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.

- b. Motors and equipment containing motors.

2.02 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Fittings for Grounding and Bonding: See Section 26 05 26 for additional requirements.
- C. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- D. Provide products listed, classified, and labeled as suitable for purpose intended.
- E. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 1/2-inch trade size.
 - 2. Branch Circuit Homeruns: 3/4-inch trade size.
 - 3. Control Circuits: 1/2-inch trade size.
 - 4. Flexible Connections to Luminaires: 3/8-inch trade size.
- F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular.com/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 - 3. Material: Use steel.
 - a. Do not use die cast zinc fittings.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 3. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. ABB; Ocal: www.electrification.us.abb.com/#sle.
 - 2. Calbond, a division of Atkore International www.calbond.com/#sle
 - 3. Robroy Industries: www.robroy.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.
- D. Interior Coating: Urethane, minimum thickness of 2 mil, 0.002 inch.

2.06 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

- B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - c. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel.
 - a. Do not use die cast zinc fittings.

2.07 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - c. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel.
 - a. Do not use die cast zinc fittings.

2.08 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

- B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel.
 - a. Do not use die cast zinc fittings.
 - 4. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.
 - 5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
 - 6. Embedded Within Concrete, Where Permitted: Use fittings listed as concrete-tight.
Fittings that require taping to be concrete-tight are acceptable.

2.09 ALUMINUM ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT aluminum electrical metallic tubing listed and labeled as complying with UL 797A.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; listed for use with aluminum EMT.
 - 2. Material: Use aluminum.
 - 3. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.

2.10 ELECTRICAL NONMETALLIC TUBING (ENT)

- A. Manufacturers:
 - 1. ABB; Carlon: www.electrification.us.abb.com/#sle.
 - 2. Cantex Inc: www.cantexinc.com/#sle.
 - 3. IPEX, a division of Aliaxis: ww.ipexna.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type ENT electrical nonmetallic tubing complying with NEMA BI 50058 and listed and labeled as complying with UL 1653.
- C. Fittings:

1. Manufacturer: Same as manufacturer of ENT to be connected.
2. Use solvent-welded type fittings.
3. Solvent-Welded Fittings: Rigid PVC fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; suitable for use with ENT.

2.11 ACCESSORIES

- A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- C. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- D. Foam Conduit Sealant:
 1. Removable, two-part, closed-cell foam, specifically designed for sealing conduit openings against water, moisture, gases, and dust.
 2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 3. Rated to hold minimum of 10 ft water head pressure.
- E. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
 1. Products:
 - a. Alta Products, LLC; Sigrist Pipe Chase Housing, Curbs, and Exit Seals: www.altaproductsllc.com/#sle.
 - b. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - c. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
- F. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
- G. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.
- D. Intermediate Metal Conduit (IMC): Install in accordance with NECA 101.
- E. PVC-Coated Galvanized Steel Rigid Metal Conduit (RMC): Install using only tools approved by manufacturer.
- F. Electrical Nonmetallic Tubing (ENT): Install in accordance with NECA 111.
- G. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route exposed conduits:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.
 - 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 - 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.

- b. Hot water piping.
 - c. Flues.
- 14. Group parallel conduits in same area on common rack.
- H. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.
 - 2. Do not support any items from metal roof decks.
 - 3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 - 4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 - 5. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 - 6. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 - 7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
 - 8. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
 - 9. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.
- I. Connections and Terminations:
 - 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 - 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 - 3. Use suitable adapters where required to transition from one type of conduit to another.
 - 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 - 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 - 6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
 - 7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.

8. Secure joints and connections to provide mechanical strength and electrical continuity.
- J. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Provide weatherproof pipe boot for all conduit penetrations through roof. Conduit through the pipe boot to be galvanized rigid steel conduit.
 7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.
- K. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where conduits are subject to earth movement by settlement or frost.
- L. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- M. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

- N. Provide grounding and bonding; see Section 26 05 26.
- O. Identify conduits; see Section 26 05 53.

3.03 INSERTS AND SLEEVES

- A. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
 - 2. Coordinate with precast supplier, prior to fabrication, to provide inserts, sleeves, openings, boxes and conduit required.
 - 3. Provide required grounding connections and pigtails to structural and slab steel prior to concrete installation.
 - 4. Coordinate with precast supplier, prior to fabrication to provide access to steel reinforcement as required for grounding.
- B. Install sleeves for cable and raceway penetrations of masonry, fire and sound rated gypsum walls and of all other fire and sound rated floor and wall assemblies.
- C. In wet area floor penetrations, top of sleeve to be 2 inches above the adjacent floor. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to the existing floor structure. Wet areas for this paragraph are rooms or spaces containing air handling unit coils, converters, pumps, chillers, boilers, and similar waterside equipment.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.05 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.06 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 05 33.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 33.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 27 26 - Wiring Devices:
 - 1. Wall plates.
 - 2. Additional requirements for locating boxes for wiring devices.
- F. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- F. NFPA 70 - National Electrical Code.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- I. UL 508A - Industrial Control Panels.
- J. UL 514A - Metallic Outlet Boxes.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, and cabinets and enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Keys for Lockable Enclosures: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
 4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
 5. Use suitable concrete type boxes where flush-mounted in concrete.
 6. Use suitable masonry type boxes where flush-mounted in masonry walls.
 7. Use raised covers suitable for the type of wall construction and device configuration where required.
 8. Use shallow boxes where required by the type of wall construction.
 9. Do not use "through-wall" boxes designed for access from both sides of wall.
 10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 12. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 13. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 14. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: Comply with Section 27 10 00.
 - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
 15. Wall Plates: Comply with Section 26 27 26.

16. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation:
www.cooperindustries.com/#sle.
 - b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
 - c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
 1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 - c. Damp or Wet Location: Type 4, stainless steel or nonmetallic..
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.

2.02 ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.
 1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.

- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
 - 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
 - 2. Unless dimensioned, box locations indicated are approximate.
 - 3. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.
 - b. Communications Systems Outlets: Comply with Section 27 10 00.
 - 4. Locate boxes so that wall plates do not span different building finishes.
 - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 - 8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.

9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:
 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- O. Close unused box openings.

- P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- Q. Provide grounding and bonding in accordance with Section 26 05 26.
- R. Identify boxes in accordance with Section 26 05 53.

3.03 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Floor marking tape.
- F. Warning signs and labels.
- G. Electrical One-Line Diagram Display

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 26 05 73 - Power System Studies: Arc flash hazard warning labels.
- C. Section 26 09 23 - Digital Modular Lighting Controls; Device and wallplate finishes; factory pre-marked wall controllers.
- D. Section 27 10 00 - Structured Cabling: Identification for communications cabling and devices.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code.
- B. UL 969 - Marking and Labeling Systems.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
 - 1. Include new directories for all existing to remain panelboards with circuits used in this project. Directory shall include new and existing loads.
- B. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location.
 - 4) Identify main overcurrent protective device. Use identification nameplate or identification label for panelboards
 - 5) Use typewritten circuit directory to identify load(s) served including room number location of devices or equipment. Identify spares and spaces.
 - a) Room number on directories shall be Owner's numbers not numbers indicated on floor plans or in panel schedules included with plans unless Owner so specifies.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Identify spare breakers, but do not identify spaces.
 - a) Where equipment is located exterior of the building or on the roof, include (Exterior) or (Roof) in identification nameplate.
 - b. Transformers:
 - 1) Identify power source and circuit number. Include location when not within sight of equipment.
 - 2) Identify load(s) served. Include location when not within sight of equipment.
 - c. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify power source and circuit number. Include location when not within sight of equipment.

- 2) Identify load(s) served. Include location when not within sight of equipment.
- d. Transfer Switches:
 - 1) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
2. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
3. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
5. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
 - a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 90 00.
6. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations indicated.
7. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.
- C. Identification for Conductors and Cables:
 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 2. Identification for Communications Conductors and Cables: Comply with Section 27 10 00.
 3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
 5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
 6. Use underground warning tape to identify direct buried cables.

D. Identification for Raceways:

1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
2. Use voltage markers, color-coded bands, or factory-painted conduits to identify systems other than normal power system for accessible conduits.
 - a. Maximum Intervals: 20 feet.
 - b. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Field-Painting: Comply with Section 09 90 00.
 - 2) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.
 - c. Color Code:
 - 1) Fire Alarm System: Red.
3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
4. Use underground warning tape to identify underground raceways.

E. Identification for Boxes:

1. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 09 90 00 per the same color code used for raceways.
 - 1) Fire Alarm System: Red.
 - b. For exposed boxes in public areas, do not color code.
2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

F. Identification for Devices:

1. Identification for Communications Devices: Comply with Section 27 10 00.
2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
3. Factory Pre-Marked Wallplates: Comply with Section 26 27 26.
4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.

G. Identification for Luminaires:

1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

H. Electrical One-Line Diagram Display

1. Electrical One-Line Diagram Display(s) at full sheet size. Printed directly on to plastic sign board or paper sheet mounted to a backboard. Rigid clear plastic cover over entire sheet(s).

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com/#sle.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - c. Seton Identification Products: www.seton.com/#sle.
2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
 - a. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:

- a. Equipment Designation: 1/2 inch.
- 5. Color:
 - a. Normal Power System: White text on black background.
 - b. NEC 700 System: White text on red background.
 - c. NEC 701 System: White text on orange background.
 - d. NEC 702 System: White text on green background.
 - e. Fire Alarm System: White text on red background.
- D. Format for General Information and Operating Instructions:
 - 1. Minimum Size: 1 inch by 2.5 inches.
 - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 1/4 inch.
 - 5. Color: Black text on white background unless otherwise indicated.
- E. Format for Receptacle Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Power source and circuit number or other designation indicated.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Black text on clear background.
- F. Format for Control Device Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Load controlled or other designation indicated.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Black text on clear background.

2.03 WIRE AND CABLE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradyid.com/#sle.
 - 2. HellermannTyton: www.hellermannntyton.com/#sle.
 - 3. Panduit Corp: www.panduit.com/#sle.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.

- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

- A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- C. Minimum Size:
 - 1. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 3. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- D. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
- E. Color: Black text on orange background unless otherwise indicated.

2.05 FLOOR MARKING TAPE

- A. Manufacturers:
 - 1. Brady Corporation; _____: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Insite Solutions, LLC; _____: www.stop-painting.com/#sle.
 - 4. Seton Identification Products; _____: www.seton.com/#sle.
- B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlamine, 3 inches wide, with alternating black and white stripes.

2.06 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Branch Devices: Adjacent to device.
 6. Interior Components: Legible from the point of access.
 7. Conduits: Legible from the floor.
 8. Boxes: Outside face of cover.
 9. Conductors and Cables: Legible from the point of access.
 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Secure rigid signs using stainless steel screws.
- G. Mark all handwritten text, where permitted, to be neat and legible.
- H. Electrical One-Line Diagram Display
 1. Install One-Line Diagram Display(s) in the main electrical room in the location noted on the plans.
 2. Securely attach One-Line Diagram Display(s) to surface. Top of display at 5' 10" AFF.

3. If the new Electrical One-Line Diagram Display(s) replace existing One-Line Diagram Displays, remove the existing displays and install the new displays in the same location.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

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SECTION 26 05 83 - WIRING CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 27 26 - Wiring Devices.
- E. Section 26 28 16.16 - Enclosed Switches.

1.03 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices.
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- C. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

1. Colors: Comply with NEMA WD 1.
 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Disconnect Switches: As specified in Section 26 28 16.16 and in individual equipment sections.
- C. Wiring Devices: As specified in Section 26 27 26.
- D. Flexible Conduit: As specified in Section 26 05 33.13.
- E. Wire and Cable: As specified in Section 26 05 19.
- F. Boxes: As specified in Section 26 05 33.16.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 09 16 - ELECTRIC CONTROLS AND RELAYS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pushbutton and selector switches.
- B. Control stations and panels.
- C. Relays and time-delay relays.
- D. Control power transformers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 33.16 - Boxes for Electrical Systems: Cabinets and terminal blocks.

1.03 REFERENCE STANDARDS

- A. NEMA ICS 1 - Industrial Control and Systems General Requirements.
- B. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays
Rated 600 Volts.
- C. NEMA IA 10030 - Industrial Control and Systems: Enclosures.
- D. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for each component showing electrical characteristics and connection requirements.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB/GE: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Rockwell Automation; _____: www.rockwellautomation.com/#sle.
- D. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

2.02 COMPONENTS

- A. Control Switches and Stations:
 - 1. Contacts: NEMA ICS 2, Form Z.
 - 2. Contact Ratings: NEMA ICS 2, A150.
 - 3. Selector Switch Operators: Two position rotary selector switch.
 - 4. Pushbutton Operator: Unguarded type.

5. Control Stations: Standard duty oiltight type pushbutton station.
- B. Magnetic Control Relays: NEMA ICS 2, Class A300.
 1. Contacts: NEMA ICS 2, Form Z.
 2. Contact Ratings: NEMA ICS 2, Class A150.
 3. Coil Voltage: 120 volts, 60 Hz, AC.
- C. Control Power Transformers: Machine tool transformer with isolated secondary winding.
 1. Power Rating: As noted on the drawings.
 2. Voltage Rating: 480 volts primary; 120 volts secondary.

2.03 ENCLOSURES

- A. Control Station Enclosures: NEMA IA 10030; Type 1.
- B. Relay Enclosures: NEMA IA 10030; Type 1.
- C. Fabrication: Shop fabricate control panels to NEMA ICS 1, using cabinets and terminal blocks furnished in accordance with Section 26 05 33.16.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install individual relays and time-delay relays in enclosures.
- C. Install cabinets in accordance with Section 26 05 33.16.
- D. Make electrical wiring interconnections as indicated.

END OF SECTION

SECTION 26 09 23 - DIGITAL MODULAR LIGHTING CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Occupancy sensors.
- B. Load controllers for lighting.
- C. Wall controllers.
- D. Conductors and cables.
- E. Daylight controls.
- F. Digital load controllers.

1.02 RELATED REQUIREMENTS

- A. Section 23 09 93 - Sequence of Operations for HVAC Controls.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- E. Section 26 05 29 - Hangers and Supports for Electrical Systems
- F. Section 26 05 33.16 - Boxes for Electrical Systems.
- G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- H. Section 26 09 18 - Remote Control Switching Devices: Remotely controlled devices for lighting control, including networked lighting controls, programmable relay panels, and remote control switching relays.
- I. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches.
- J. Section 26 28 13 - Fuses.
- K. Section 26 51 00 - Interior Lighting.

1.03 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- D. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
- E. NFPA 70 - National Electrical Code.
- F. UL 924 - Emergency Lighting and Power Equipment.
- G. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

H. IECC - International Energy Conservation Code

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of wall controllers with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate placement of wall switch occupancy sensors with installed door swings.
3. Coordinate placement of occupancy sensors with millwork, furniture, equipment and other potential obstructions to motion detection coverage.
4. Coordinate placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement.
5. Coordinate lighting control device product selections with luminaire characteristics; see Section 26 51 00 and lighting fixture schedule.
6. Provide dimming system that is compatible with each light fixture's dimming method as shown on the approved light fixture submittals.
7. Notify Architect of conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include ratings, operating modes or sequence of functions, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

1. Occupancy Sensors: Include detailed motion detection coverage range diagrams for all proposed sensor types.

C. Shop Drawings:

1. Device Serial Numbers: Provide lighting plan(s) with lighting control device serial number stickers applied. Scan plans and submit digital copy. Submit hard copy and scanned digital copy to Owner.
2. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.

3. Digital Load Controllers: Provide dimensioned plan views indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing factory and field connections. Include manufacturer product characteristics and application instructions for wired and wireless applications, including start-up and commissioning.
 4. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.
 5. Wall Controllers: Provide lighting plan indicating location, and model number, of each wall controller and associated system component.
 6. Power Packs: Provide lighting plan indicating location, and model number of each power pack and associated system component,
- D. Field quality control reports.
1. Indicate that lighting control programming has been completed per the Lighting Control Sequence of Operation as listed on the Drawings.
 2. Indicate tested and approved lighting controls on a per-room/area basis.
- E. Operation and Maintenance Manual:
1. Product cut sheets of all items installed.
 2. Installation instructions.
 3. Include detailed information on device programming and setup.
 4. As-built shop drawings.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
- G. Project Record Documents: Record actual installed lighting control devices

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

- B. Provide five year manufacturer warranty for all lighting control devices and cabling included in this specification section.
- C. Provide five year manufacturer warranty for digital load controllers.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A. Wireless and wired digital lighting control system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. Provide all conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.
- D. Products for Switching of Electronic Ballasts/Drivers: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.
- E. Lighting control system components shall be capable of providing the functionality listed in the Lighting Control Sequence of Operations on the Drawings.
- F. Sensor locations shown on the Drawings are diagrammatic and indicate the general design intent. Contractor shall enlist the manufacturer to design a digital modular lighting control system that provides control of lighting through a proprietary system of sensors, control stations and room controllers.
- G. System shall provide programmable functions including the following:
 - 1. Occupancy and Vacancy Control.
 - a. Ability to program system to activate scenes or zones to preset levels based on occupancy or vacancy.
 - 2. Manual Control.
 - a. Scene Based dimming and switching.
 - b. Zone Based dimming and switching.
 - 3. Daylight Harvesting Control.
 - a. Provide dimming control to select luminaire zones based on availability of daylight sensed by one or more daylight sensors.
 - 4. Each room/area shall function as a standalone system.
 - 5. System shall have distributed intelligence that does not rely on a central controller.
 - 6. All equipment and software required to program the system shall be included with the system and turned over to the owner.
- H. Unless specifically noted, all wall control stations and cover plates shall match color requirements for Wiring Devices as noted in 26 27 26.

2.02 MANUFACTURERS

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle. **(Basis of Design)**

- a. Where light fixtures have nLight AIR embedded components, provide nLight AIR wall controllers and related devices.
 - b. Where light fixtures do not have nLight AIR embedded components, provide nLight wired lighting control components.
2. Hubbell Incorporated: www.hubbell.com/#sle.
3. Legrand North America, Inc: www.legrand.us/#sle.
- B. Substitutions: See Section 01 60 00 - Product Requirements.
 1. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

2.03 INTERIOR OCCUPANCY SENSORS

- A. Layout Verification.
 1. Sensor layouts on drawings are provided to show general intent and coordination.
 2. Manufacturer-trained technicians shall review layout with their product offering and contractor shall provide additional sensors, as needed, to ensure reliable, trouble-free, and full coverage operation in all areas.
- B. Occupancy Sensors.
 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 2. Sensor Technology.
 - a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
 - b. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using combination of both passive infrared and ultrasonic technologies.
 - c. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using combination of both passive infrared and audible sound sensing technologies.
 3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
 4. Operation: Refer to Lighting Control Sequence of Operations on the Drawings.
 5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
 6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.

7. Area of coverage: provide minor motion or major motion coverage as indicated by occupancy sensor symbol and legend description.
 8. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
 9. Sensitivity: Field adjustable.
 10. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
 11. Integral Photocell: For field selectable and adjustable inhibition of automatic turn-on of load when ambient lighting is above selected level.
 12. Load Rating for Line Voltage Occupancy Sensors: As required to control load indicated on drawings.
 13. Wireless Sensors:
 - a. RF Range: 30 feet through typical construction materials.
 - b. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B application.
 - c. Power: Battery-operated with minimum ten-year battery life.
- C. Wall Switch Occupancy Sensors:
1. Wall Switch Occupancy Sensors:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
 - b. Unless otherwise indicated or required to control load indicated on drawings, provide line voltage units with self-contained relay.
 - c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
 - d. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
 - e. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during delayed-off time interval.
 - f. Finish: White.
 - g. Provide vandal resistant lenses for wall switch occupancy sensors.
- D. Ceiling Mounted Occupancy Sensors:
1. General Requirements:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Unless otherwise indicated or required to control load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - c. Provide field selectable setting for disabling LED motion detector visual indicator.

- d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
- e. Finish: White unless otherwise indicated.

2.04 LOAD CONTROLLERS FOR DIGITAL LIGHTING CONTROLS

- A. Load controllers shall function as the hubs for each area or room and shall provide lighting zone switching and dimming as required. One or more room controller zones shall be provided in each area to provide the following functions.
 - 1. Plenum rated, self-contained low voltage class 2 transformer and relay(s) compatible with specified low voltage lighting control devices.
 - 2. Provide quantity and configuration of load controllers with all associated wiring and accessories as required to control the lighting loads indicated on drawings.
 - 3. Air gap contacts rated for 20A of LED driver or LED driver loads.
 - 4. Dimming control to each zone of luminaires which is indicated to be dimmed on the Lighting Control Sequence of Operations on the Drawings.
 - a. Dimmers shall provide smooth, silent dimming down to the lowest dimming percentage as specified on the Luminaire Schedule using the dimming method specified on the Luminaire Schedule.
 - 5. Separate load controller zones/outputs shall be provided:
 - a. For each lighting control zone, as indicated on drawings.
 - b. For each circuit, as indicated on drawings.
 - c. For each room or area.
 - d. As necessary to power the quantity of sensors/wall controllers provided in an area.
 - e. As necessary to control the quantity of luminaires provided in an area.
 - f. For each luminaire type within an area.
 - g. For each dimming or switching type within an area.
- B. Input Supply Voltage: Dual rated for 120/277 V ac.
- C. Provide separate load controller or isolated relay for light fixtures on Emergency power to comply with NEC requirements for emergency circuit isolation.
- D. Load Rating: As required to control load indicated on drawings.

2.05 WALL CONTROLLERS

- A. Wall control button control stations shall be fully programmable and shall be provided with the functionality and button quantity as indicated on the drawings.
- B. Graphic touch screen stations
 - 1. LCD touchscreen control interface that provides:
 - a. At least, 16 scene controls and 16 On/Off/Dim controls.
 - b. Password protection and screen saver

- c. User Prompts and Helps screens
- d. Basic setup and programming of associated zones/scenes.
- e. USB input for local programming with an Owner provided computer.

2.06 UL924 EMERGENCY FUNCTIONALITY

- A. Unless specifically noted with an “NL” or “Night Light” designation, all luminaires shown connected to an NEC 700 branch shall be controlled in the same manner of adjacent luminaires under normal circumstances but shall be energized in the event of a power outage.
- B. Where luminaires are dimmed, UL924 control shall include functionality allow dimmed control in normal circumstances and drive the fixtures to full when activated in a way that is compatible with dimming method specified on the Luminaire Schedule.
- C. UL924 Control may be accomplished integral with UL924 Room Controllers or may be accomplished with the addition of standalone UL924 controllers.

2.07 DIGITAL LOAD CONTROLLERS

- A. System Description:
 - 1. Stand-alone system, including interconnected modules and accessories, for lighting load low-voltage control as indicated on drawings, schedules, written sequences of operation, and reviewed shop drawings.
 - 2. Product standard system configurations preconfigured out of box, plug-and-play, automatically self-addressing devices for communications, and without need to field configure or program features, or requiring device setting adjustments. LEDs on unit indicate operation and troubleshooting without software intervention.
 - 3. Provide quantity and configuration of power and slave packs, communication modules, and load expansion modules, including associated wiring, wired and wireless components, and accessories to control loads indicated.
 - 4. Also referred to as room, area, or architectural digital load controllers, as indicated, depending on space and functionality. Each controller includes one or more channels for load control, also referred to as zones.
 - 5. Provide networkable digital load controllers and system components for future integration of luminaires and devices.
- B. General Requirements:
 - 1. Listed for powering and controlling line-voltage loads, power packs, contactors, relays, and other lighting control devices.
 - a. Design Lighting Consortium (DLC) listed.
 - 2. Input Supply Voltage: Dual rated for 120/277 VAC.
 - 3. Cabling Terminations:
 - a. Provide field fabricated, and tested before installation, control wiring.

- b. Include two RJ 45 or mechanical screw-based terminal block wiring connections.
- 4. Compatibility:
 - a. Compatible with luminaires specified with integral sensors; include auxiliary contact closure accessory components for controls indicated.
 - b. Compatible with wired and wireless sensors and communication protocols for controlling line-voltage loads.
 - 1) Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B application.
- 5. Provide UL 2043 plenum rated control unit with self-contained relay(s) and low-voltage class 2 transformer, compatible with specified wired and wireless sensors, components, and ballasts/drivers.
 - a. Comply with NFPA 70 for use in plenum spaces.
 - b. Provide UL 2043 plenum rating for associated system control components for control indicated.
- 6. Surface Mounting: Standard junction box attachments.
- 7. Provide one auxiliary contact closure output where indicated.
- 8. Minimum Load Rating: As required to control load indicated on drawings.
- 9. Control Inputs:
 - a. Digital: Two.
 - b. Analog: One.
- 10. Output Control Capability:
 - a. Single Zone Switching Modules: One programmable channel.
 - b. Multi-Zone Switching Modules: Up to three separately programmable channels.
- 11. Emergency Branch Circuit Loads:
 - a. Comply with NFPA 70 for controlling or bypassing emergency branch circuits as indicated.
 - b. Provide UL 924 listed components.
- C. Additional Integrated Requirements for Digital Load Controllers:
 - 1. Central Monitoring and Management: Include programmable user interface for lighting system controllable features; control access locally by plugging into devices and LAN network via browser-based software with settings retained in nonvolatile memory.
 - 2. Provide additional auxiliary contact closure outputs where required for functions and operating modes indicated.
 - 3. Scheduling:
 - a. Include timer and clock configurator for full calendar year and daylight savings automatic adjustments based on time zone.

- b. Provide function for hold-on, designed within time limitations or other restrictions of presiding energy code.
 - c. Demand Response: Load shed or hold-off capability.
- 4. Occupancy Controls:
 - a. Scene Control: Occupant selections by lighting control devices for controls as indicated.
 - b. Bi-level Switching: Multi-level lighting for controls as indicated.
 - c. Dimming: Occupancy controlled dimming, including blink warning; see indicated controls for percent light-level after programmed delay time.
 - d. Shade Control: Interfacing capability.
- 5. Daylight Harvesting:
 - a. System Description:
 - 1) Control system with compatible control modules, power packs, contactors, or relays as required for automatic control of load indicated according to available natural light.
 - 2) System control responds to changes in measured light levels according to selected settings.
 - 3) Capable of integrating with daylighting sensors, occupancy sensors, and manual override controls.
 - b. Daylighting Control Photo Sensors: Low-voltage class 2 photo sensor units with output signal proportional to measured light level and provision for zero or offset based signal.
 - 1) Sensor Type: Filtered silicon photo diode.
 - 2) Sensor Range:
 - a) Indoor Photo Sensors: 5 to 100 footcandles.
 - 3) Finish: White unless otherwise indicated.
 - 4) Where wired sensors are indicated, wireless sensors are not acceptable without prior approval of Architect.
 - a) RF Range: 30 feet through typical construction materials.
 - b) Power: Battery-operated with minimum ten-year battery life.
 - c. Dimming Photo Sensors: Photo sensor units with integral controller compatible with specified dimming ballasts/drivers, for direct continuous dimming of up to 50 ballasts/drivers.
 - d. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.

- e. Daylight Control Switching Modules: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with no-switching dead band between set points to prevent unwanted cycling.
- f. Daylight Control Dimming Module Operation:
 - 1) Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
 - 2) Load to be turned off when available daylight is sufficient to fully dim load, after selected time delay.
 - 3) Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
 - 4) Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.
 - 5) Output Voltage: Compatible with specified dimming ballasts/drivers.
- 6. Accessories:
 - a. Where indicated, provide compatible accessory wall switches for manual override control.

2.08 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. Class 2 and 3 Control Cable:
 - 1. As required by manufacturer.
 - 2. Plenum Rated.
 - 3. Cable Jacket Color:
 - a. Black.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

- F. Verify that service voltage and ratings of lighting control devices are appropriate for service voltage and load requirements at location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes as required for installation of lighting control devices; see Section 26 05 33.16.
- C. Maintain separation of remote-control, signaling, and power-limited circuits.
 - 1. See manufacturer instructions and Section 26 05 19 for control wiring conductors, wiring methods, and identification requirements.
- D. Install lighting control devices in accordance with manufacturer's instructions.
- E. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- F. Install lighting control devices plumb and level, and held securely in place.
- G. Where required and not furnished with lighting control device, provide wall plate; see Section 26 27 26.
- H. Provide required supports; see Section 26 05 29.
- I. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- J. Identify lighting control devices; see Section 26 05 53.
- K. Occupancy Sensor Locations:
 - 1. Sensor locations shown on the Drawings are diagrammatic and indicate the general design intent. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's approved shop drawings.
 - 2. Locate dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

3. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
 4. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- L. Load Controller Installation
1. Load Controllers shall be installed to the exterior of junction boxes where low voltage wiring is allowed to be installed without conduit.
 2. Where conduit is required for low voltage wiring, a separated junction box (or two boxes joined together) shall be provided.
 3. All Load Controllers shall be installed concealed in accessible areas or visible within electrical rooms.
 - a. Load Controllers should be located above a wall controller in the respective room above the suspended ceiling or at 10' AFF in rooms without suspended ceilings. For rooms with gypsum ceilings, Load Controllers should be installed as close as possible to the room served, with the Load Controllers being installed above a suspended ceiling or at 10' AFF in rooms without suspended ceilings.
 4. Identify each Load Controller's installed location on the As-Built Shop Drawings and within the manufacturer's produced lighting control layout drawings and floor plans for the Operations and Maintenance Manual.
- M. Daylighting Control Photo Sensor Locations:
1. Location Adjustments: Within design intent, reasonably minor adjustments to locations may be made in order to optimize control and avoid conflicts or problems affecting proper detection of light levels.
 2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure light level controlled at designated task location, while minimizing measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
 3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into space, while minimizing measured amount of lighting from artificial sources.
- N. Unless otherwise indicated, install Load Controllers for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.
- O. Support low voltage cables independent from suspended ceilings. Maximum support interval 4 feet.
- P. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

- Q. Where indicated or required, provide cabinet or enclosure for mounting of lighting control device system components; see Section 26 05 33.16.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area.
- D. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
- E. Correct wiring deficiencies and replace damaged or defective conductors, cables, and lighting control devices.
- F. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - 1. Perform the following tests and inspections:
 - a. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Lighting control devices will be considered defective if they do not pass tests and inspections.
 - 3. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated on the Lighting Control Sequences of Operation.
- C. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.
- D. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
- E. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.06 PROGRAMMING

- A. Record all lighting control device identification tags and device locations as required by the manufacturer for startup.
- B. Program the system as required by the Lighting Control Sequences of Operation on the Drawings.
- C. System shall be programmed using the most comprehensive version of the software.
 - 1. Software designed for iOS or Android is acceptable only when it has all the features as the desktop/laptop version of the software.
 - 2. Lite or Trial versions of the software are not acceptable

3.07 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.08 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed..
- D. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training time to Owner.
 - 3. Instructor: Qualified contractor familiar with the project, with sufficient knowledge of the installed lighting control devices, and trained by the manufacturer on the software required to program the installed lighting control devices.
 - 4. Location and time: At project site. Coordinate Training time with Owner at least two weeks in advance.

END OF SECTION

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SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manual wall switches.
- B. Receptacles.
- C. Cord and Plug Sets
- D. Wall plates and covers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 26 05 33.23 - Surface Raceways for Electrical Systems: Surface raceway systems, including multioutlet assemblies.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 09 23 - Digital Modular Lighting Controls: Devices for automatic control of lighting, including occupancy sensors and digital wall controllers.
- F. Section 26 27 23 - Indoor Service Poles.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices.
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- G. NFPA 70 - National Electrical Code.
- H. UL 20 - General-Use Snap Switches.
- I. UL 498 - Attachment Plugs and Receptacles.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.
- K. UL 943 - Ground-Fault Circuit-Interrupters.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.

3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Project Record Documents: Record actual installed locations of wiring devices.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICES - GENERAL REQUIREMENTS

- A. Provide wiring devices suitable for intended use with ratings adequate for load served.
- B. Wiring Device Applications:
 1. Receptacles Installed Outdoors or in Damp or Wet Locations: Use weather-resistant GFCI receptacles with weatherproof covers.
 2. Single Receptacles Installed on Individual Branch Circuits: Provide receptacle ampere rating equal to branch circuit rating.
- C. Wiring Device Finishes:
 1. Provide wiring device finishes as described below, unless otherwise indicated.
 2. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.
 3. Wiring Devices Installed in Finished Spaces: White with white nylon wall plate.
 4. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
 5. Wiring Devices Installed in Wet or Damp Locations: White with weatherproof cover.

6. Wiring Devices Connected to Generator Power: Red with red nylon wall plate.

2.02 MANUAL WALL SWITCHES

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.03 RECEPTACLES

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - a. Submit documentation that wiring devices are compatible with proposed conductor type or termination methods.
 2. NEMA configurations specified are according to NEMA WD 6.
- C. Straight-Blade Type Receptacles:
 1. Receptacles: Commercial specification grade, NEMA configurations as indicated on the drawings.
 - a. General purpose receptacles 20A, 125V , NEMA 5-20R.
- D. GFCI Receptacles:
 1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
3. Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.04 WALL PLATES AND COVERS

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.
 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
- B. Wall Plates: Comply with UL 514D.
 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Standard.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
 4. Provide wall plate by same manufacturer as respective wiring device.
- C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- E. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- F. Weatherproof Receptacle Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws.
- G. Weatherproof Receptacle Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.
- K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- N. Identify wiring devices in accordance with Section 26 05 53.
- O. Support Cord Reels and accessories directly from structure. Provide C-channel supports spanning structure as required. Do not support cord reels from metal roof decking.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.

- C. Operate each wall switch with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust floor box covers to be level and flush with adjacent floor surface.
- C. Adjust poke-through covers to be level and flush with adjacent floor surface.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 28 13 - FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fuses.
- B. Spare fuse cabinet.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 26 28 16.16 - Enclosed Switches: Fusible switches.

1.03 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses.
- B. NFPA 70 - National Electrical Code.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses.
- E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - a. Fusible Enclosed Switches: See Section 26 28 16.16.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
 - 1. Spare Fuse Cabinet: Include dimensions.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Fuses: One set(s) of three for each type and size installed.
 - 3. Fuse Pullers: One set(s) compatible with each type and size installed.
 - 4. Spare Fuse Cabinet Keys: Two.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com/#sle.
- B. Littelfuse, Inc: www.littelfuse.com/#sle.
- C. Mersen: ep-us.mersen.com/#sle.

2.02 APPLICATIONS

- A. General Purpose Branch Circuits: Class RK1, time-delay.
- B. Individual Motor Branch Circuits: Class RK5, time-delay.
- C. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
- H. Class CC Fuses: Comply with UL 248-4.
- I. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- J. Provide the following accessories where indicated or where required to complete installation:
 - 1. Fuseholders: Compatible with indicated fuses.
 - 2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

2.04 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.
- B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet in convenient location in main electrical room unless otherwise indicated.
- D. Identify spare fuse cabinet in accordance with Section 26 05 53.

END OF SECTION

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SECTION 26 28 16.16 - ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.
- E. Section 26 28 13 - Fuses.
- F. Section 26 36 00 - Transfer Switches: Automatic and non-automatic switches listed for use as transfer switch equipment.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- D. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems.
- E. NFPA 70 - National Electrical Code.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- H. UL 98 - Enclosed and Dead-Front Switches.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Prior to submitting Enclosed Switches Product Data for review, submit and obtain approval for the Power System Studies, Section 26 05 73.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- D. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
 - 2. Include wiring diagrams showing all factory and field connections.
 - 3. Identify mounting conditions required for equipment seismic qualification.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Project Record Documents: Record actual locations of enclosed switches.
- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. See Section 26 28 13 for requirements for spare fuses and spare fuse cabinets.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB/GE: www.electrification.us.abb.com/#sle.

- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- E. Source Limitations: Provide enclosed switches and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
 - 2. Minimum Ratings:
 - a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.
 - b. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
 - 1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- I. Conductor Terminations: Suitable for use with the conductors to be installed.
- J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- L. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.

ENCLOSED SWITCHES

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- N. Heavy Duty Switches:
1. Comply with NEMA BS 31047.
 2. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

- J. Identify enclosed switches in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

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SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Emergency lighting units.
- C. Exit signs.
- D. LED drivers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information.
- B. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products.
- C. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- E. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems.
- F. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility.
- G. NFPA 70 - National Electrical Code.
- H. NFPA 101 - Life Safety Code.
- I. UL 924 - Emergency Lighting and Power Equipment.
- J. UL 1598 - Luminaires.
- K. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
 - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.

3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
 3. Emergency Power Supply Unit: Include associated lumen output and battery information.
- D. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 60 00 - Product Requirements, for additional provisions.
- F. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide 3-year manufacturer warranty for LED luminaires, including drivers.
- C. Provide 5-year pro-rata warranty for batteries for Emergency Lighting Units and Emergency Power Supply units that are integral or directly connected to light fixtures.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

H. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

I. Emergency Power Supply Unit: Where listed on the light fixture schedule, include one integrated Emergency Power Supply Unit with 90 minute battery for each luminaire.

2.03 EMERGENCY LIGHTING UNITS

- A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- C. Battery:
1. Sealed maintenance-free lead calcium unless otherwise indicated.
 2. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- E. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- F. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
- G. Accessories:
1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
 2. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.04 EXIT SIGNS

- A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
1. Number of Faces: Single- or double-face as indicated or as required for installed location.
 2. Directional Arrows: As indicated or as required for installed location.
- B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.
1. Self-Powered Exit Signs:

- a. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- b. Battery: Sealed, maintenance-free, nickel cadmium unless otherwise indicated.
- c. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- d. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- e. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

2.05 LED DRIVERS

A. LED Drivers - General Requirements:

- 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
- 2. Minimum Efficiency/Efficacy: Provide drivers complying with all current applicable federal and state ballast efficiency/efficacy standards.

B. Dimmable LED Drivers:

- 1. Dimming Range: Continuous dimming range as indicated on the Light Fixture Schedule on the drawings, without flicker.
- 2. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.06 ACCESSORIES

- A. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.

- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
 - 4. Secure pendant-mounted luminaires to building structure.
 - 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- H. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
 - 4. Install canopies tight to mounting surface.
- J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

- K. Install accessories furnished with each luminaire.
- L. Bond products and metal accessories to branch circuit equipment grounding conductor.
- M. Emergency Lighting Units:
 - 1. Unless otherwise indicated, connect unit to unswitched power. Bypass local switches, contactors, or other lighting controls.
- N. Exit Signs:
 - 1. Unless otherwise indicated, connect unit to unswitched power. Bypass local switches, contactors, or other lighting controls.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Test self-powered exit signs, emergency lighting units, and emergency power supply units to verify proper operation upon loss of normal power supply.
- E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy LED drivers as determined by Architect.

3.05 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
- C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.06 CLEANING

- A. Clean surfaces according to manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

3.08 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other communications work.

1.02 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition.
- E. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition.
- F. MFMA-4 - Metal Framing Standards Publication.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- H. NFPA 70 - National Electrical Code.
- I. TIA-569 - Telecommunications Pathways and Spaces.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable supports, channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. TIA-569.
 - b. NFPA 70.
 - c. Requirements of authorities having jurisdiction.
 - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of communications work.
 - 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.

4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of 100%. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit Supports: Straps and clamps suitable for conduit to be supported.
 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
- D. Metal Channel/Strut Framing Systems:
 1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 2. Comply with MFMA-4.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
 1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:

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1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners in accordance with manufacturer's recommended torque settings.
- I. Remove temporary supports.

END OF SECTION

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SECTION 27 05 33.13 - CONDUIT FOR COMMUNICATIONS SYSTEMS

PART 2 PRODUCTS

1.01 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70 and TIA-569.
- B. Provide conduit, fittings, supports, and accessories required for complete communications pathway.
- C. Provide products listed, classified, and labeled as suitable for purpose intended.
- D. Where conduit size is not indicated, size to comply with NFPA 70, TIA-569, and BICSI TDMM, but not less than applicable minimum size requirements specified. Where specified standards differ, comply with most stringent.

PART 3 EXECUTION

2.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.
- C. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Connections and Terminations:
 - 1. Use suitable adapters where required to transition from one type of conduit to another.
 - 2. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect cables.
 - 3. Secure joints and connections to provide mechanical strength and electrical continuity.
- E. Penetrations:
 - 1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 - 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 - 3. Provide sleeves and/or slots for penetrations as indicated or as required to facilitate installation.
 - 4. Conceal bends for conduit risers emerging above ground.
 - 5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.

6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.
- F. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed cables or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where conduits are subject to earth movement by settlement or frost.
- G. Provide grounding and bonding.
- H. Through-Penetration Firestopping
1. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration firestop systems products.
 - a. Seal all openings or voids made by penetrations to ensure an air and water-resistant seal.
 - b. Protect materials from damage on surfaces subjected to traffic.
 2. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
 3. Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
 4. Fire Rated Cable Pathways: Gangable device modules capable of being retrofitted around existing cables and comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill and requiring no additional action in the form of plugs, twisting closure, putty, pillow, or sealant to achieve fire and leakage ratings. Device's must be maintenance free having a corresponding Evaluation Services Report from a Nationally Recognized Third Party Laboratory. Maintenance free is defined as requiring no additional action in the form of plugs, twisting closure, putty, pillow, or sealant to achieve fire and leakage ratings. The following products are acceptable:
 5. Specified Technologies Inc. (STI) EZ-Path Fire Rated Pathway

6. Acceptable Manufacturer: Specified Technologies Inc., 210 Evans Way, Somerville, NJ 08876. Tel: (800) 992-1180, Fax: (908) 526-9623, Email: specseal@stifirestop.com, Website: www.stifirestop.com.

2.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Correct deficiencies and replace damaged or defective conduits.
- C. Inspections: Owner shall engage a qualified independent inspection agency to inspect through-penetration firestop systems in accordance with ASTM E2174, "Standard Practice for On Site Inspection of Installed Fire Stops".
- D. Keep areas of work accessible until inspection by authorities having jurisdiction.
- E. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

END OF SECTION

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SECTION 27 10 00 - STRUCTURED CABLING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Communications outlets.
- E. Communications grounding and bonding.
- F. Communications identification.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 36 - Cable Trays for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 27 05 33.13 - Conduit for Communications Systems.

1.03 REFERENCE STANDARDS

- A. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition.
- B. NFPA 70 - National Electrical Code.
- C. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set.
- D. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
- E. TIA-569 - Telecommunications Pathways and Spaces.
- F. TIA-606 - Administration Standard for Telecommunications Infrastructure.
- G. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- H. UL 444 - Communications Cables.
- I. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
- J. UL 1863 - Communications-Circuit Accessories.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
 - 3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.

4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- D. Evidence of qualifications for installer.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- F. Field Test Reports.
- G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 1. Record actual locations of outlet boxes and distribution frames.
 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 3. Identify distribution frames and equipment rooms by room number on drawings.
- H. Contractor shall provide owner with label samples for project. Owner has the right to reject at no cost.
- I. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.06 PRODUCT DRAWINGS AND SPECIFICATIONS

- A. The Contractor shall carefully examine the Drawings and Specifications of all trades and report all discrepancies to the Technology Consultant in writing to obtain corrective action. No departures from the Contract Documents will be made without prior written approval from the Technology Consultant.
- B. Questions or disputes regarding the intent or meaning of Contract Documents shall be resolved by the interpretation of the Architect/ Technology Consultant. The Architects' interpretation is final and binding.
- C. The Drawings and Specifications are not intended to define all details, finish materials, and special construction, which may be required or necessary. The Contractor shall provide all installations complete and adequate as implied by the project documents.

- D. Drawings are diagrammatic only and do not show exact routes and locations of equipment and associated wiring. The Contractor shall verify the work of all other trades and shall arrange there work to avoid conflicts. In the event of a conflict, the Contractor shall obtain corrective action from the Technology Consultant.
- E. The Contractor shall verify all site conditions and upon acceptance of the project takes responsibility for the entire scope of work.
- F. If there is a conflict between contract documents, the document highest in precedence shall control. The precedence shall be: first; permits from agencies as required by law, second; special provisions, third; specifications, fourth; drawings, fifth; reference specifications and sixth; vendor submittals.

1.07 QUALITY ASSURANCE

- A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- B. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
- C. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
 - 2. The bidder shall have a fulltime on staff Registered Communication Distribution Designer (RCDD) with three (3) years' experience with projects of this size or, on staff. Submit the RCDD Certificate and project information with bid.
 - 3. Supervisors and installers factory certified by manufacturers of products to be installed.
 - 4. Employing a full-time on-staff BICSI Registered Cabling Installation Technicians (RCIT) for supervision of all work.
 - 5. The Contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data and voice network systems.
 - 6. Those licenses/permits required to perform telecommunications installations in the specified jurisdiction.
 - 7. The Contractor shall provide proof of current certification for the installed systems.
 - 8. Personnel must be knowledgeable in local, state, and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall apply.
 - 9. The Contractor must possess and maintain current liability insurance certificates.
 - 10. Contractor is to field verify all conditions of the project.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Contractor must attend all construction weekly meetings.

1.08 MOCKUPS

- A. Provide on request at no cost to the owner, mockups for Equipment Outlet configurations, especially those for Wireless Access Points, surface-mounted, harsh environment and other unique conditions as applicable to verify selections made under Sample submittals, to demonstrate configuration, capacity and aesthetics and to set quality standards for fabrication and installation. Coordinate with Division 26 and other Division 27 requirements as applicable to include all power and communications devices.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.
- C. Storage of materials off site shall be no cost to the owner.

1.10 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 1 week period after Date of Substantial Completion.
- C. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract or any equipment which is damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the Owner.

1.11 USE OF SITE

- A. Where the Owner deems it necessary to place restrictions, use the site as directed by the Owner.
- B. When proceeding with the work, do not interfere with the ordinary use of streets, aisles, passages, exits, or operations of the Owner. During the day, set up cones and barriers in hallways and walkways. Do not string cable down the hallways during normal hours.
- C. Request a hazardous materials worksheet that identifies potentially-hazardous locations. Do not proceed with any work in locations where hazardous materials are known to be. Obtain instructions from the Owners Project Manager on and when to work in these areas.
- D. Multiple times each day, each contractor shall remove all trash and debris from the site. Before leaving the room each day:
 - 1. The Contractor shall replace all ceiling tiles that they have removed. Ceiling tiles that have been damaged are to be replaced at no cost to the owner.
 - 2. In occupied areas ceiling tiles are to be placed back into the grid after work has been conducted for the day.
 - 3. The Contractor shall place all furniture and equipment that they have moved back into its original location.

4. The contractor shall verify with the owner in writing before any equipment is to be taken off line.
5. The Contractor shall return any equipment that they have disconnected to working order. When work is completed and equipment is connected the Contractor shall verify with the Owner that all equipment is operating properly.
6. The Contractor's Job Foreman shall inspect all work locations to ensure that the rooms are clean and that all of the tasks described above have been done.
7. It is recommended that the Contractor inspect the site and take pictures to document the condition of the ceilings and walls before and after work has been completed.

1.12 CONTINUITY OF SERVICES

- A. Take no action that will interfere with or interrupt existing building services unless previous arrangements have been made with the Owner's representative. Arrange all work to minimize shutdown time.
- B. The Owner's personnel shall perform shutdown of operating systems. When shutdown of systems is required, the Contractor shall give three (3) days advance notice.
 1. Should building services be inadvertently interrupted:
 2. The Job Foreman shall immediately notify the Project Manager of the accidental disruption of services, the remedy, and how long it will take to restore services.
 3. The Contractor shall immediately furnish the labor, including overtime, the material, and the equipment necessary to promptly restore the interrupted service at no cost to the Owner.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
 1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
 2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
 3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
- B. System Description:
 1. Offices and Work Areas: Provide one data outlet in each work area.

- C. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.
 - 1. Locate main distribution frame as indicated on the drawings.
- D. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.02 PATHWAYS

- A. Conduit: See section 27 05 33.13.
- B. Cable Trays: See Section 26 05 36.
- C. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
 - 1. Products:
 - a. STI Fire Stop.
 - b. HILTI.

2.03 COPPER CABLE AND TERMINATIONS

- A. Manufacturers:
- B. Copper Horizontal Cable:
 - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
 - 2. Cable Type - Data: TIA-568.2 Category 6 UTP (unshielded twisted pair); 23 AWG.
 - 3. Cable Capacity: 4-pair.
 - 4. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
 - 5. Cable Jacket Color -Data Cable: Blue.
 - 6. Product(s):
 - a. Panduit Cat 6A Plenum PUP6AM04*UG
 - b. Panduit Cat 6A Non Plenum PUP6AS04*CG
 - c. General Cat 6A Plenum 7141849
 - d. General Cat 6A Non Plenum 7143849
 - e. CommScope Giga Speed Cat 6A Plenum 760107201
 - f. Comm Scope Giga Speed Cat 6A Non Plenum 760107094
 - g. CommScope Uniprise Cat 6A Plenum CS34P
 - h. CommScope Uniprise Cat 6A Non Plenum
- C. Conduits for data embeded in concrete or on grade below slab, indoor/outdoor shall be installed. Plenum Cat 6.
 - 1. Product(s)

- a. Hubbell Cat 6A Indoor/Outdoor Plenum C6A1OSPBK or equal.
 - b. Hubbell Cat 6 Indoor/Outdoor Plenum C61OSPBK or equal.
-
- A. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
 - B. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
 1. Performance: 500 mating cycles.
 2. Data Jacks: 8-position modular jack, color-coded for T568B wiring configurations.
 3. Product(s):
 - C. Copper Patch Cords:
 1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
 2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: _____ feet.
 3. Patch Cords for Work Areas:
 - a. Quantity: One for each work area outlet port.
 - b. Length: _____ feet.
 4. Product(s):

2.04 COMMUNICATIONS OUTLETS

- A. Manufacturers:
 1. Panduit.
- B. Outlet Boxes: Comply with Section 26 05 33.16.
 1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
 2. Minimum Size, Unless Otherwise Indicated:
 - a. Data Outlets: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
- C. Wall Plates:
 1. Comply with system design standards and UL 514C.
 2. Accepts modular jacks/inserts.
 3. Capacity:
 - a. Data Outlets: four ports.

2.05 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with Communication Service Provider requirements.
- C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

3.02 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 - 2. Do not over-cinch or crush cables.
 - 3. Do not exceed manufacturer's recommended cable pull tension.
 - 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
 - 5. Manufacturer approved conduit bushings **MUST** be in place on every conduit opening that cable will be installed in prior to running the cable. Confirm before cable installation.
 - 6. Hook and loop straps (Velcro) will be used to prevent changes in the physical geometry of the cable. **Cable ties and black electrical tape is not permitted.**
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
 - 1. At Distribution Frames: 120 inches.
 - 2. At Outlets - Copper: 12 inches.
 - 3. At Outlets - Optical Fiber: 39 inches.
- C. Copper Cabling:
 - 1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 - 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 - 3. Use T568B wiring configuration.
- D. Identification:
 - 1. Use wire and cable markers to identify cables at each end.
 - 2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
 - 3. Access Control
 - a. Contractor to provide access control cabling, and install owner provided devices..
 - 1) Access control cabling shall be installed in separate pathway, sleeves and properly firestopped.

- 2) Contractor will verify with owner on cable types and quantities.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Comply with inspection and testing requirements of specified installation standards.
- C. Visual Inspection:
 1. Inspect cable jackets for certification markings.
 2. Inspect cable terminations for color coded labels of proper type.
 3. Inspect outlet plates and patch panels for complete labels.
- D. Testing - Copper Cabling and Associated Equipment:
 1. Test operation of shorting bars in connection blocks.
- E. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION

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SECTION 28 46 00 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping: Materials and methods for work to be performed by this installer.
- B. Designed using manufacturer's product-specific design software or based on manufacturer's pre-engineered design suitable for the application.
- C. Section 08 71 00 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
- D. Section 14 21 00 - Electric Traction Elevators: Elevator systems monitored and controlled by fire alarm system.
- E. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Supervisory and alarm devices installed in sprinkler system.
- F. Section 23 33 00 - Air Duct Accessories: Smoke dampers controlled by fire alarm system.
- G. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- H. Section 26 05 33.13 - Conduit for Electrical Systems.
- I. Section 26 05 33.16 - Boxes for Electrical Systems.
- J. Section 26 05 53 - Identification for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
- B. ADA Standards - 2010 ADA Standards for Accessible Design.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
- D. NFPA 70 - National Electrical Code.
- E. NFPA 72 - National Fire Alarm and Signaling Code.

1.04 PERFORMANCE REQUIREMENTS

- A. Manufacturer and contractor shall be responsible for the final system design per state and local AHJ, codes and ordinances. Contractor to confirm with local Fire Marshal that cellular monitoring of the fire alarm system is acceptable. Final system design subject to approval by AHJ. Bid and Contract documents are intended to show only general intent and coordination.
- B. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
 2. Heat detectors.
 3. Smoke detectors.
 4. Verified automatic alarm operation of smoke detectors.
 5. Automatic sprinkler system water flow.
 6. Fire extinguishing system operation.
 7. Fire standpipe system.
 8. Duct Smoke detectors shall NOT initiate alarm signal.
- C. Fire alarm signal shall initiate the following actions:
1. Alarm notification appliances shall operate continuously.
 2. Identify alarm at the FACP and remote annunciators.
 3. De-energize electromagnetic door holders.
 4. Transmit an alarm signal to the remote alarm receiving station.
 5. Unlock electric door locks in designated egress paths.
 6. Release fire and smoke doors held open by magnetic door holders.
 7. Activate voice/alarm communication system.
 8. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
 9. Recall elevator. Send signal to turn off elevator power after cab has been recalled.
 10. Record events in the system memory.
- D. Supervisory signal initiation shall be by one or more of the following devices or actions:
1. Operation of a fire-protection system valve tamper.
 2. Activation of AHU shutdown by duct smoke detector. Send signal to shut down respective AHU.
- E. System trouble signal initiation shall be by one or more of the following devices or actions:
1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
 2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
 3. Loss of primary power at the FACP.
 4. Ground or a single break in FACP internal circuits.
 5. Abnormal ac voltage at the FACP.
 6. A break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at the FACP or annunciator.
- F. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Proposal Documents: Submit the following with cost/time proposal:
 - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
 - 3. Certification by Contractor that the system design will comply with Contract Documents.
- C. Evidence of designer qualifications.
- D. Shop Drawings: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. System zone boundaries and interfaces to fire safety systems.
 - 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 - 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 - 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 - 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 - 9. Description of power supplies; battery calculations demonstrating adequate battery power.
 - 10. Detailed drawing of graphic annunciator(s).
 - 11. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 - 12. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
 - 13. Certification by Contractor that the system design complies with Contract Documents.
 - 14. Submit Shop Drawings to AHJ for review and approval. Submittal to AHJ to be done in a timely fashion. Do not start fire alarm system construction until approval is received from AHJ.
- E. Evidence of installer qualifications.
- F. Evidence of instructor qualifications; training lesson plan outline.
- G. Inspection and Test Reports:

1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- H. Operating and Maintenance Data: See Section 01 78 00 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Complete set of shop drawings, as approved by authority having jurisdiction.
 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing warranty service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- I. Project Record Documents: See Section 01 78 00 for additional requirements; have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- J. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
- K. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
 3. In addition to the items in quantities indicated in PART 2, furnish the following:

- a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
- b. One copy, on CD-ROM, of all software not resident in read-only-memory.

1.06 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
 4. Warranty maintenance office located within 50 miles of project site.
 5. Certified in the State in which the Project is located as fire alarm installer.
- D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- C. At the end of the project, the Contractor shall post the warranty period along with the company's name and telephone number inside the fire alarm panel.

- D. Any occupied facility shall not be without a UL and an NFPA approved and fully operational fire alarm system for a period longer than two (2) hours. Emergency response shall be provided within two (2) hours of the notification, to the contractor, of the failure of the system to perform operationally per UL and NFPA standards. Non-emergency service calls shall be responded to within twenty-four (24) hours of the notification to the contractor.
- E. Emergency situations may include, but not limited to:
 - 1. System can't be acknowledged or reset
 - 2. System is non-responsive to commands
 - 3. System in non-responsive to actuated alarm devices
 - 4. Malfunction of notification/initiating circuit(s)
 - 5. System going into alarm/trouble without indicating the source
 - 6. System is dead (no power), etc.
- F. Repairs and/or replacement arising from emergency situations shall be completed within twenty-four (24) hours of the time of notification. Other than emergency, actual repairs and /or replacement shall be provided within seventy-two (72) hours of the time of notification during normal working hours, Monday through Friday, excluding holidays. If the repairs involve parts that are not shelf items and require lead time, the contractor shall inform the Owner within twenty-four (24) hours from the time of notification of the exact time when the repairs will be completed.
- G. If repair and/or replacement cannot be made within the prescribed time, then other means and methods of protection shall be provided to ensure the safety of the building's occupants during which time the system is not in compliance with the standards. This may involve up to and include hiring Owner approved qualified personnel to stand a fire watch, all at the contractor's expense.
- H. Warranty service for the equipment shall be provided by the system supplier's factory trained representative. Further, Warranty shall include all parts, labor and necessary travel.

1.08 EXTRA MATERIALS

- A. Provide the extra materials to the Owner at the completion of the project:
 - 1. Two (2) fire alarm cabinet keys.
 - 2. Two (2) manual pull station reset keys.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Alarm Control Units and Accessories:
 - 1. Honeywell Security & Fire Solutions/Fire-Lite: www.firelite.com/#sle.
 - 2. Simplex, a brand of Johnson Controls: www.simplex-fire.com/#sle.
- B. Initiating Devices and Notification Appliances:

1. Honeywell Security & Fire Solutions/Fire-Lite; _____: www.firelite.com/#sle.
2. Same manufacturer as control units.

2.02 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new addressable / intelligent voice fire detection and alarm system:
1. Provide all components necessary for a complete and functioning system.
 2. Protected Premises: Entire building shown on drawings.
 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the State Fire Marshal.
 - c. The requirements of the local authority having jurisdiction .
 - d. Applicable local codes.
 - e. Contract Documents (drawings and specifications).
 - f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 4. Evacuation Alarm: general audible (voice) and visual notification of entire premises.
 5. Fire Alarm Control Panel: New, located as shown on the Drawings.
 6. Do not combine fire alarm system with other non-fire systems.
- B. Supervising Stations and Fire Department Connections:
1. Public Fire Department Notification: By on-premises supervising station.
- C. Circuits:
1. Initiating Device Circuits (IDC): Class B, Style A.
 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
 3. Notification Appliance Circuits (NAC): Class B, Style W.
- D. Spare Capacity:
1. Initiating Device Circuits: Minimum 25 percent spare capacity.
 2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
 3. Speaker Amplifiers: Minimum 25 percent spare capacity.
 4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- E. Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
 2. Secondary: Storage batteries.
 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

2.03 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
 - 1. Sprinkler water control valves.
 - 2. Dry-pipe sprinkler system pressure.
 - 3. Dry-pipe sprinkler valve room low temperature.
 - 4. Elevator shut-down control circuits.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
 - 1. Sprinkler water flow.
 - 2. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
- C. Elevators:
 - 1. Elevator lobby, hoistway, and elevator control room smoke detectors: Elevator recall for fire fighters' service.
 - 2. Elevator Control Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
 - 3. Elevator Hoistway Heat Detector(s): Shut down elevator power prior to hoistway sprinkler activation.
 - 4. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.
- D. HVAC:
 - 1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
- E. Doors:
 - 1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 71 00.
 - 2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 08 71 00.

2.04 COMPONENTS

- A. General:
 - 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted units are acceptable.
 - 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Main Fire Alarm Control Panel:
 - 1. General Description:
 - a. Modular, power-limited design with electronic modules, UL 864 listed.

- b. Addressable initiation devices that communicate device identity and status.
 - 1) Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
 - 2) Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 - c. Addressable control circuits for operation of mechanical equipment.
 - d. Actuation of alarm notification appliances, emergency voice communications, annunciation, smoke control, and elevator recall shall occur within 10 seconds after the activation of an initiating device.
2. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
- a. Annunciator and Display: Liquid-crystal type,
 - b. 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.
3. Circuits:
- a. Signaling Line Circuits: Style and Class as required by the AHJ and codes for the building occupancy and construction type.
 - b. Notification Appliance Circuits: Style and Class as required by the AHJ and codes for the building occupancy and construction type.
 - c. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.
4. Smoke-Alarm Verification:
- a. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
 - b. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
 - c. Sound general alarm if the alarm is verified.
 - d. Cancel FACP indication and system reset if the alarm is not verified.
5. Transmission to Remote Alarm Receiving Station:
- a. Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a cellular digital alarm communicator transmitter.
6. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.
7. Walk Test:

- a. A test mode to allow one person to test alarm and supervisory features of initiating devices.
 - b. Enabling of this mode shall require the entry of a password.
 - c. The FACP and annunciators shall display a test indication while the test is underway.
 - d. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.
8. Remote Smoke-Detector Sensitivity Adjustment:
 - a. Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings.
 - b. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups.
 - c. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.
9. Transmission to Remote Alarm Receiving Station:
 - a. Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.
10. Voice/Alarm Signaling Service:
 - a. A central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of the FACP.
 - 1) Allow the application of and evacuation signal to indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - 2) Programmable tone and message sequence selection.
 - 3) Standard digitally recorded messages for "Evacuation" and "All Clear."
 - 4) Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the FACP.
11. Status Annunciator:
 - a. Indicate the status of voice/alarm speaker and the status of one-way all call communication system.
12. Primary Power:
 - a. 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.

- b. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
 - c. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."
- 13. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
 - a. Batteries: Sealed lead calcium.
 - b. Battery and Charger Capacity: Comply with NFPA 72.
- 14. Surge Protection:
 - a. Install surge protection on normal ac power for the FACP and its accessories.
 - b. Install surge protectors recommended by FACP manufacturer.
- 15. Instructions:
 - a. Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame.
 - b. Include interpretation and describe appropriate response for displays and signals.
 - c. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
- C. Remote Annunciator(s):
 - 1. Description:
 - a. Duplicate annunciator monitoring and control functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.
 - b. Voice paging handset.
 - c. Mounting: Flush cabinet, NEMA 250, Class 1.
 - 2. Display Type and Functional Performance:
 - a. Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.
- D. Addressable Modules:
 - 1. Provide addressable modules suitable for connection to fire alarm control unit signaling line circuits.
 - 2. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.
 - 3. Monitor Modules: Unless devices are explicitly permitted to be connected together as zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable fire alarm control unit.

4. Control Modules: Provide as indicated or as required for selective control of notification appliances.
 5. Relay Modules: Provide as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.
 6. Signaling Line Circuit (SLC) Isolating Modules: Provide as indicated or as required to automatically isolate short circuits on connected sections of SLC loops and allow other sections to continue to function normally. Provide automatic reset upon correction of short circuit.
- E. Initiating Devices:
1. Manual Fire Alarm Boxes
 - a. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.
 - 1) Double-action mechanism requiring two actions to initiate an alarm, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
 - 2) Station Reset: Key- or wrench-operated switch.
 2. Fire Alarm System Detectors:
 - a. General Description:
 - 1) UL 268 listed, operating at 24-V dc, nominal.
 - 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - 4) Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
 - 5) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6) Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
 - 7) Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

- a) Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg per minute.
 - b) Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F.
 - c) Provide multiple levels of detection sensitivity for each sensor.
- b. Photoelectric Smoke Detectors:
 - 1) Sensor: LED or infrared light source with matching silicon-cell receiver.
 - 2) Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
- c. Duct Smoke Detectors:
 - 1) Photoelectric Smoke Detectors:
 - a) Sensor: LED or infrared light source with matching silicon-cell receiver.
 - b) Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
 - 2) UL 268A listed, operating at 24-V dc, nominal.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - 4) Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
 - 5) Self-Restoring: Detectors shall 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. Provide remote status and alarm indicator and test station.
 - 7) Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
 - 8) Each sensor shall have multiple levels of detection sensitivity.
 - 9) Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
 - 10) Remote test/indicator station:
 - a) Keyed test switch with LED indicators.
- 3. Heat Detectors:

- a. Elevator hoistway, elevator control room; fixed temperature sensor. Lower temperature actuation than adjacent fire protection sprinkler head temperature.
 - b. Rate-of-rise temperature sensor. Lower temperature actuation than adjacent fire protection sprinkler head temperature.
- F. Notification Appliances:
- 1. Description: Equipped for mounting as indicated and with screw terminals for system connections.
 - a. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
 - 2. Voice/Tone Speakers:
 - a. UL 1480 listed.
 - b. Mounting: Flush, semi-recessed, or surface mounted; bidirectional as indicated.
 - c. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.
 - d. Finish: as selected by the Architect.
 - e. Fire alarm speakers shall be labeled "FIRE".
 - f. Vandal resistant metal or Lexan housing or grills.
 - g. Sealed backs to protect the phenolic impregnated cone.
 - h. Field adjustable output taps ranging from 1/4 watt to 2 watts.
 - i. Speakers selected for this project shall produce a Sound Pressure Level, at the 1 watt tap of at least 82 dBA at 10 feet – as tested per UL Standard 1480.
 - 3. Strobes:
 - a. ALL strobes, and the strobe portion of audible/strobe combination units, shall be of the Xenon type.
 - b. Rated Light Output: as noted on the drawings unless a higher rating is .
 - c. Fire alarm strobes shall have clear lenses and labeled "FIRE".
 - d. Designed for synchronized flash operation at one flash per second (1 Hz) minimum over the device's listed input voltage range. Strobes shall be synchronized such that all strobe units within the building shall flash simultaneously (As a minimum, all devices on each floor shall flash simultaneously, with flash timing within the limits established by current UL standards.).
 - e. Synchronized such that all strobe units within the building shall flash simultaneously
 - 1) As a minimum, all devices on each floor shall flash simultaneously, with flash timing within the limits established by current UL standards.
 - 4. Exterior horn/strobe:
 - a. Weatherproof
 - b. Locate above the sprinkler system Siamese connection.

- c. Strobe per requirements above.
 - d. Horn
 - 1) Configured for either temporal three output or steady output.
 - 2) Produce a sound-pressure level of 90 dBA measured 10 feet from the horn with a multiple-frequency tone.
 - 3) Selectable high or low dB output with a reduction of approximately 6 dBA.
 - 4) Fire alarm horns shall be labeled "FIRE".
 - e. Coordinate required color with Architect.
- G. Cellular Digital Alarm Communicator Transmitter
- 1. Listed and labeled according to UL 632.
 - 2. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
 - 3. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.
 - 4. Contractor to confirm that the proposed cellular digital transmitter is compatible with the monitoring company selected by the Owner.
- H. Power/Audio Booster panels
- 1. Where they are used, "NAC Power Booster Panels" shall be individually supervised. Interconnecting NAC Booster Panels in a manner, which prevents identification of individual panel TROUBLE conditions, shall not be approved.
 - 2. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
- I. Digital Alarm Communicator Transmitter
- 1. Listed and labeled according to UL 632.
 - 2. Functional Performance
 - a. Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.
 - 3. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

- 4. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.
- J. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.
- K. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
 - 1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
 - 2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
 - 3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.
- L. Locks and Keys: Deliver keys to Owner.
 - 1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type
- M. Storage Cabinet for System Record Documents: Steel with baked enamel finish, size appropriate for record documents.
 - 1. Desk type door held open at 90 degrees for use as a working surface. Stainless steel piano hinge.
 - 2. Two key ring hooks to hold system keys, accommodations for 8 1/2" x 11" manuals and document records, and area for business cards for key contact personnel.
 - 3. Access door shall be locked with a 3/4" barrel lock.
 - 4. RED Finish with 1" high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
 - 5. Locate as directed by Owner.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the approved shop drawings.
- B. Install all wiring in conduit.
- C. Connect the FACP and NAC Booster Panels to dedicated Emergency Power Branch Circuits where available.
- D. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- E. Install instruction cards and labels.
- F. Duct detectors:

1. Duct smoke detector installation to be by this contractor and should be installed in the locations shown on the mechanical and electrical plans. Ensure that the duct smoke detectors are in serviceable locations. Consult with the mechanical designer for alternate locations if these are shown in non-serviceable locations. When locations on mechanical plans are not available, install in locations called for that provide accessibility for service. For duct smoke detectors that are associated with shaft smoke dampers, ensure the sampling tubes protruding into the duct are located within five feet of the smoke damper and there are no air inlets or outlets between the sampling tubes and the damper. Do not install within four feet of a fan discharge.
 2. Install Remote Test/Indicator Stations as shown on drawings. Where location not shown on drawings, locate in accessible location near the respective duct detector.
- G. Addressable Modules:
1. Install fire alarm addressable modules within 3 feet of the device controlled or monitored.
- H. Initiating Device Protection:
1. Install dust protection covers on all initiating devices until project area is free from construction dust.
 2. Ensure that all dust protection covers are removed at project completion.
- I. Indicating appliances:
1. Where ceiling mounted type indicating appliances are installed in areas without a ceiling, pendant mount the bottom of the indicating appliance at the same level as the bottom of the adjacent light fixtures.
 2. Exterior horn/light: coordinate with the fire protection contractor that a separate exterior bell is not installed over the Siamese connection as the fire alarm system horn/strobe will be installed in that location.
- J. Power/audio Booster Panels
1. If NAC Booster Panels are needed at locations other than those identified on the construction drawings, the Electrical Contractor shall obtain approval for their proposed installation locations. At such locations, the EC shall provide any required circuit breakers, associated power wiring, and local smoke detection at the approved location. Power shall be obtained from the nearest available emergency panel. The cost of such equipment and installation shall be included within the base Electrical Bid.
 2. Provide smoke detection at all proposed NAC booster panels and fire alarm audio amplifiers.
- K. Elevators:
1. Install heat detectors within 2 feet of sprinkler heads in elevator hoistways and elevator control rooms.
 2. Install smoke detectors at elevator landings, top of hoistway and in elevator control room.

3.02 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.03 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 - 1. Hands-On Instruction: On-site, using operational system.
- B. Basic Operation: One 2-hour session for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
- C. Detailed Operation: One 2-hour session for Owner facility personnel.
 - 1. Initial Training: 1 session pre-closeout.
 - 2. Set day/time of training in writing with Owner at least 2 weeks in advance of the training session.
- D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.04 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.

5. Repeat demonstration until successful.

END OF SECTION

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SECTION 31 23 16 - EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavating for footings and new exterior area well as shown on plans..
- B. Temporary excavation support and protection systems.

1.02 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction.

PART 2 PRODUCTS - NOT USED

2.01 MATERIALS

- A. Bedding and Fill to Correct Over-Excavation:
 - 1. See Section 31 23 23 for bedding and corrective fill materials at general excavations.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench mark and intended elevations for the work are as indicated.
- B. Survey existing adjacent structures and improvements and establish exact elevations at fixed points to act as benchmarks.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.
- C. Protect bench marks, survey control points, existing structures, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- D. Protect plants, lawns, rock outcroppings, and other features to remain.
- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.
Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect.

3.03 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

- A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.

3.04 EXCAVATING

- A. Excavate to accommodate new structures and construction operations.
 - 1. Excavate to the specified elevations.
 - 2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.

- B. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measured by volume.
- E. Provide temporary means and methods, as required, to remove all water from excavations until directed by Architect. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.05 FILLING AND BACKFILLING

- A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.
- B. See Section 31 23 23 for fill, backfill, and compaction requirements at general excavations.

3.06 CLEANING

- A. Remove excavated material that is unsuitable for re-use from site.
- B. Remove excess excavated material from site.

3.07 PROTECTION

- A. Divert surface flow from rains or water discharges from the excavation.
- B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.
- D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
- E. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION

SECTION 31 23 23 - FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Filling, backfilling, and compacting for footings and foundations.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 31 23 16 - Excavation: Removal and handling of soil to be re-used.

1.03 REFERENCE STANDARDS

- A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
- B. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill: Complying with State of Wisconsin Highway Department standard.
- B. Structural Fill: Complying with State of Wisconsin Highway Department standard.
- C. Granular Fill - Gravel : Pit run washed stone; free of shale, clay, friable material and debris.

2.02 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. If tests indicate materials do not meet specified requirements, change material and retest.
- C. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Verify areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

- A. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.

- B. Employ a placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- F. Correct areas that are over-excavated.
 - 1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- G. Compaction Density Unless Otherwise Specified or Indicated:
- H. Reshape and re-compact fills subjected to vehicular traffic.
- I. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 FILL AT SPECIFIC LOCATIONS

- A. At Foundation Walls and Footings:
 - 1. Use general fill.
 - 2. Do not backfill against unsupported foundation walls.

END OF SECTION

SECTION 32 12 16 - ASPHALT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Single course bituminous concrete paving.

1.02 RELATED REQUIREMENTS

- A. Section 31 23 23 - Fill: Compacted subgrade for paving.

1.03 REFERENCE STANDARDS

- A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
- B. AI MS-2 - Asphalt Mix Design Methods.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Wisconsin Highways standard.
- B. Mixing Plant: Complying with State of _____ Highways standard.
- C. Obtain materials from same source throughout.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aggregate for Wearing Course: In accordance with State of Wisconsin Highways standards.

2.02 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Asphalt Wearing Course: 5 to 7 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 AGGREGATE BASE COURSE

- A. Place and compact aggregate base course.

3.03 PLACING ASPHALT PAVEMENT - SINGLE COURSE

- A. Install Work in accordance with State of Wisconsin Highways standards.
- B. Place asphalt within 24 hours of applying primer or tack coat.
- C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- D. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.04 PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for two (2) days or until surface temperature is less than 140 degrees F.

END OF SECTION