

PROJECT MANUAL & BID DOCUMENTS

#25-C-0019
HEERAN CENTER HVAC SYSTEM UPGRADE



100 W. 13th Avenue
Eugene, Oregon 97401

CONTRACT ADMINISTRATOR
Jared L Young
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PROJECT #25-C-0019

HEERAN CENTER HVAC SYSTEM UPGRADE

PRE-BID MEETING:

**10 AM, TUESDAY, APRIL 1, 2025
Heeran Center
2222 Coburg Rd
Eugene, Oregon 97401**

BIDS DUE:

TUESDAY, APRIL 15, 2025, 2 PM

**Homes for Good Housing Agency
100 W. 13th Avenue
Eugene, Oregon 97401**

PROJECT MANUAL

250002.01

Home For Good

Heeran Center HVAC System Upgrade

100% CONSTRUCTION DOCUMENTS

March 13, 2025

Owner:

Homes For Good

100 West 13th Avenue

Eugene, Oregon 97401

Phone: (541) 852-2879

Contact: Jared Young

Contract Administrator

jyoung@homesforgood.org

Mechanical & Electrical Engineer:

Systems West Engineers, Inc.

725 A Street

Springfield, Oregon 97477

Phone: (415) 323-8934

Contact: Charlie L. White, PE

Project Manager

cwhite@systemswestengineers.com

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REQUEST FOR BIDS

#25-C-0019

HEERAN CENTER HVAC SYSTEM UPGRADE

REQUEST FOR BIDS

The Agency (Homes for Good Housing Agency) will be accepting Bids from licensed and bonded contractors for upgrading the existing HVAC system at the Agency Owned Heeran Center, located in Eugene, Oregon. The contractor shall provide all labor, materials, some equipment, permits, inspections, and all necessary fees and costs in the performance of the project work. All work shall be accomplished in accordance with the incorporated Request for Bids, Drawings, Specifications, federal, state, and local codes and regulations, and to the highest industry standards.

Contractors, Sub-Contractors, Section 3 Certified Contractors, and all Minority Business Enterprises are encouraged to participate in this solicitation. Digital copies of the specifications and drawings describing the work can be requested from the project's Contract Administrator, Jared Young, via email at jyoung@homesforgood.org.

Work under these contracts is subject to BOLI Prevailing wage rates and requirements. You can access these wage rates and occupation definitions at <https://www.oregon.gov/boli/employers/pages/prevailing-wage.aspx>.

1. PRE-BID MEETING:

The **pre-bid meeting will be held on Tuesday, April 1, 2025, at 10 AM. The meeting address is 2222 Coburg Rd, Eugene, OR 97401. A site visit will immediately follow.**

All interested contractors are encouraged to attend.

2. BIDS DUE:

All Bids for the work must be received at the Agency offices, 100 W. 13th Avenue, Eugene, Oregon 97401, **no later than 2 PM, Tuesday, April 15, 2025.** Bids are to be submitted on the forms provided in this Project Manual; in all cases, the submission must be an original, be complete and signed.

3. SECURITY

Bid security in the amount of 5% of the bid is due at the time of bid submission.

4. CONTRACT ADMINISTRATION

The Contract Administrator for this solicitation is Jared L Young. He may be contacted by writing to the Homes for Good Housing Agency, 100 W 13th Ave, Eugene, OR 97401, or by phone at (541) 852-2879. Email: jyoung@homesforgood.org

5. PROJECT DESCRIPTION

The Project Site addresses: 2222 Coburg Rd, Eugene, OR 97401

This document, the Specification sections, included with the project manual, and drawings detail the work to be accomplished.

Schedule:

The Agency expects to issue the Notice to Proceed effective approximately **Monday, April 28, 2025**. The Contractor will have 243 calendar days from that date to complete the work. Final completion is anticipated to be no later than **Friday, December 26, 2025**.

6. PLAN CHECK AND PERMITS

The Agency will secure the basic building permit for the project; the Contractor is responsible for coordinating all inspections, and all other necessary fees, costs and additional permits required by governing authorities in the performance of the contract and shall be reimbursed by the Agency. The Contractor is responsible for coordinating all inspections.

7. OREGON CONSTRUCTION CONTRACTOR'S REGISTRATION AND ENDORSEMENT

All contractors shall be currently licensed with the Oregon Construction Contractor's Board (CCB). The license shall be properly endorsed for the work to be performed.

Bidders for this project will have either a Residential or Commercial GENERAL CONTRACTOR endorsement, whichever is required according to the structure classification defined in ORS830.070. Surety Bonds valued according to the endorsement are to be current and on file with the CCB.

Sub-contractors working for the General Contractor of this project will be licensed through the CCB with the appropriate endorsement for the work to be performed. This information will be noted and certified on the Contractor/Subcontractor Agreement form.

8. APPLICABLE WAGE RATES

Prevailing wage rates are required on this project. This is state funded work and therefore subject to BOLI wage Rates, payment and reporting requirements. The prevailing wage rates (including basic hourly rate and fringe benefits) determined to be prevailing wage with respect to an employee in any trade or position employed under this contract, are applicable to all employees engaged under the contract

When the contract exceeds \$50,000.00, State of Oregon Overtime payment rules apply.

Apprentice wage rates are to be based on an apprenticeship program registered with the Department of Labor or a BOLI-recognized State Apprenticeship Program; and any applicable trainee wage rate based thereon as specified in a BOLI-certified trainee programs.

9. CONSTRUCTION DOCUMENT AVAILABILITY:

Digital copies of the drawings, manual, and specifications can be obtained by calling the Contract Administrator, Jared L Young at (541) 852-2879, emailing at jyoung@homesforgood.org, or downloaded from the Agency's website at <https://www.homesforgood.org/opportunities/contracts-and-vendors/bid-opportunities>.

10. SECTION 3 CLAUSE

N/A

11. INSURANCE REQUIREMENTS

At signing of contract, the awarded Contractor is required to provide the Agency with Certificates of Insurance showing the following Insurance is in force and will insure all operations under this contract:

A. GENERAL CONTRACTOR:

(1) WORKERS' COMPENSATION, in accordance with State Law. The general contractor, its subcontractor, and all employers working under the contract are subject employers under the Oregon Workers' Compensation Law and shall comply with ORS 656.017, or otherwise be exempt under ORS 656.126.

(2) AUTOMOBILE LIABILITY for owned and non-owned motor vehicles used on the site or in connections therewith for a combined single limit for bodily injury and property damage of not less than \$1,000,000 per occurrence.

(3) COMMERCIAL GENERAL LIABILITY and Professional Liability: the minimum limit of liability shall be \$2,000,000 per occurrence written, with a combined single limit for bodily injury and property damage.

The General Contractor's General Liability policy shall name the Agency "Additional Insured" for this project, with an attached Endorsement Page, showing the additional insured as:

**Homes for Good Housing Agency
100 W. 13th Avenue
Eugene, Oregon 97401**

B. SUBCONTRACTOR are all subcontractor insurance certificates must be on file with the Agency prior to initiation of work (submitted to General Contractor who provides Agency a copy):

(1) WORKERS' COMPENSATION, in accordance with State Law.

All employers working under the contract are subject employers under the Oregon Workers' Compensation Law and shall comply with ORS 656.017, or must otherwise be exempt under ORS 656.126.

(2) Automobile liability for owned and non-owned motor vehicles used on the site or in connections therewith for a combined single limit for bodily injury and property damage of not less than \$500,000 per occurrence.

(3) Commercial General Liability and Professional Liability: the minimum limit of liability shall be \$1,000,000 per occurrence written, with a combined single limit for bodily injury and property damage.

12. FIRST TIER SUBCONTRACTOR DISCLOSURE (ORS 279.027(1.(3))

Subcontractor disclosure is required on all public improvement contracts greater than \$100,000.

13. SUBSTITUTING FIRST-TIER SUBCONTRACTORS: N/A

14. ENVIRONMENTAL CARE

Awarded Contractor shall comply with all applicable federal, state, and local laws and regulations, including but not limited to those dealing with the prevention of environmental pollution and the preservation of natural resources that affect the performance of the contract. A list of entities who have enacted such laws or regulations is found in the Oregon Attorney General's Model Public Contract Rules Manual, OAR 137-030-0010, Commentary 4. If new or amended statutes, ordinances, or regulations are adopted, or the contractor encounters a condition not referred to in the bid document not caused by the contractor and not discoverable by reasonable site inspection which requires compliance with federal, state, or local laws or regulations dealing with the prevention of environmental pollution or the preservation of natural resources, both Homes for Good Housing Agency and the contractor shall have all the rights and obligations specified in ORS 279C.525 to handle the situation.

15. DRUG FREE WORKPLACE REQUIREMENT:

In order to meet the requirements of the Drug Free Workplace Act each contractor must certify and agree to the following provisions before contract award (certification statement included on bid form).

- a. Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the PHA's workplace and specifying the actions that will be taken against employees for violation of such prohibition.
- b. Establishing a drug-free awareness program to inform employees about the following:
 - (1) The dangers of drug abuse in the workplace;
 - (2) The Companies policy of maintaining a drug-free workplace;
 - (3) Any available drug counseling, rehabilitation, and employee assistance programs; and
 - (4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.
- c. Making it a requirement that each employee of the Company be given a copy of the statement required by paragraph a.;
- d. Notifying the employee in the statement required by paragraph a. that, as condition of employment with the Company, the employee will–
 - (1) Abide by the terms of the statement; and

- (2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction.
- e. Notifying the Housing Authority within ten days after receiving notice under subparagraph d. (2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to the Contract Administrator on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notices shall include the identification number(s) of each affected grant;
 - f. Taking one of the following actions within 30 days of receiving notice under subparagraph d. (2) with respect to any employee who is so convicted:
 - (1) Taking appropriate personnel action against such an employee, up to and including termination; consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
 - (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;
 - g. Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs a. through f.

16. ADDENDA RECEIPT

Prospective Bidders are responsible for verifying with the Contract Administrator whether or not any Addenda have been issued for this project and that the bidder has received all Addenda that have been issued. Contractors are required to phone a minimum of five days prior to the date of the Bid opening to verify the issue of any Addenda.

17. AWARD OF CONTRACT

Homes for Good Housing Agency is prohibited from making any awards to contractors or accepting as subcontractors any individuals or firms which are on lists of contractors ineligible to receive awards from the United States.

A contract will be awarded to the responsible bidder submitting the lowest Bid, provided the bid is reasonable and affordable, complies with the Instructions to Bidders, and is in the interest of Homes for Good Housing Agency to accept it. The bidder to whom the award is made will be notified at the earliest practicable date. Homes for Good Housing Agency reserves the right to reject any and all bids not in compliance with all prescribed public bidding requirements and may reject for good cause or

waive any informality in Bids received whenever such rejection or waiver is in the public interest to do so.

By execution of a contract with Homes for Good Housing Agency, the contractor certifies, under penalty of perjury that: (a) To the best of contractor's knowledge, contractor is not in violation of any tax laws described in ORS 305.380(4), and (b) Contractor has not discriminated against minority, women or small business enterprises in obtaining any required subcontracts.

18. PAYMENT BOND AND PERFORMANCE BOND

Separate Assurance of completions.

For Contracts equal to or exceeding \$100,000.00 in value, the successful bidder will be required to furnish (prior to execution of the contract) assurance of completion which secures the faithful performance of the contract, and for the payment of all persons, firms or corporations to whom the contractor may become legally indebted for labor, materials, tools, equipment, or services, of any nature, employed or used by the Contractor in performing the work. Such assurances shall bear the same date as, or a date subsequent to, the date of the Contract. The current power of attorney for the person who signs for any surety company shall be attached to the bonds.

PAYMENT BOND: all Contractors submitting a bid for \$100,000.00 or greater must be capable of providing a Payment Bond in the amount of 100 percent of the contract price, from a guarantee or surety company acceptable to the U.S. Government and licensed to doing business in the State of Oregon.

PERFORMANCE BOND: In addition to the Payment Bond, all Contractors submitting a bid for \$100,000.00 or greater must be capable of providing a Performance Bond in the amount of 100 percent of the contract price, from a guarantee or surety company acceptable to the U.S. Government and licensed to doing business in the State of Oregon.

Also see Instructions to Bidders, HUD Form 5369.

19. PUBLIC WORKS BOND: For contracts exceeding \$100,000.00 where work is performed for a public entity, the State of Oregon requires a \$30,000.00 payment bond be on file with the Oregon Contractor's Board prior to execution of a contract.

20. EXECUTION OF CONTRACT

Subsequent to award and within ten (10) days after the prescribed forms are presented for signature, the successful bidder shall execute and deliver to Homes for Good Housing Agency a contract in the form furnished by Homes for Good Housing Agency.

In order to execute the contract, the bidder must submit the following forms along with the signed contract:

1. Certificates of Insurance
2. W-9
3. Bid Breakdown

21. RETAINAGE:

As permitted by state law:

- a. Retainage is 5 percent
- b. 5% retainage will be withheld on all progress payments of contract
- c. Retainage will be released upon final acceptance by the Agency of all contract work and receipt of all close-out documents.
- d. Interest will not accrue on retainage, and
- e. Bonds or securities may not be substituted as an alternate form of retainage.
- f. Retainage of 25% will be withheld on contract progress payments when labor/wage reporting is in arrears for work covered under the progress payment.

END OF SECTION

**U.S. Department of Housing and
Urban Development**
Office of Public and Indian Housing

**Instructions to Bidders for Contracts
Public and Indian Housing Programs**

Instructions to Bidders for Contracts

Public and Indian Housing Programs

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1. Bid Preparation and Submission

(a) Bidders are expected to examine the specifications, drawings, all instructions, and, if applicable, the construction site (see also the contract clause entitled **Site Investigation and Conditions Affecting the Work** of the *General Conditions of the Contract for Construction*). Failure to do so will be at the bidders' risk.

(b) All bids must be submitted on the forms provided by the Public Housing Agency/Indian Housing Authority (PHA/IHA). Bidders shall furnish all the information required by the solicitation. Bids must be signed and the bidder's name typed or printed on the bid sheet and each continuation sheet which requires the entry of information by the bidder. Erasures or other changes must be initialed by the person signing the bid. Bids signed by an agent shall be accompanied by evidence of that agent's authority. (Bidders should retain a copy of their bid for their records.)

(c) Bidders must submit as part of their bid a completed form HUD-5369-A, "Representations, Certifications, and Other Statements of Bidders."

(d) All bid documents shall be sealed in an envelope which shall be clearly marked with the words "Bid Documents," the Invitation for Bids (IFB) number, any project or other identifying number, the bidder's name, and the date and time for receipt of bids.

(e) If this solicitation requires bidding on all items, failure to do so will disqualify the bid. If bidding on all items is not required, bidders should insert the words "No Bid" in the space provided for any item on which no price is submitted.

(f) Unless expressly authorized elsewhere in this solicitation, alternate bids will not be considered.

(g) Unless expressly authorized elsewhere in this solicitation, bids submitted by telegraph or facsimile (fax) machines will not be considered.

(h) If the proposed contract is for a Mutual Help project (as described in 24 CFR Part 905, Subpart E) that involves Mutual Help contributions of work, material, or equipment, supplemental information regarding the bid advertisement is provided as an attachment to this solicitation.

2. Explanations and Interpretations to Prospective Bidders

(a) Any prospective bidder desiring an explanation or interpretation of the solicitation, specifications, drawings, etc., must request it at least 7 days before the scheduled time for bid opening. Requests may be oral or written. Oral requests must be confirmed in writing. The only oral clarifications that will be provided will be those clearly related to solicitation procedures, i.e., not substantive technical information. No other oral explanation or interpretation will be provided. Any information given a prospective bidder concerning this solicitation will be furnished promptly to all other prospective bidders as a written amendment to the solicitation, if that information is necessary in submitting bids, or if the lack of it would be prejudicial to other prospective bidders.

(b) Any information obtained by, or provided to, a bidder other than by formal amendment to the solicitation shall not constitute a change to the solicitation.

3. Amendments to Invitations for Bids

(a) If this solicitation is amended, then all terms and conditions which are not modified remain unchanged.

(b) Bidders shall acknowledge receipt of any amendment to this solicitation (1) by signing and returning the amendment, (2) by identifying the amendment number and date on the bid form, or (3) by letter, telegram, or facsimile, if those methods are authorized in the solicitation. The PHA/IHA must receive acknowledgement by the time and at the place specified for receipt of bids. Bids which fail to acknowledge the bidder's receipt of any amendment will result in the rejection of the bid if the amendment(s) contained information which substantively changed the PHA's/IHA's requirements.

(c) Amendments will be on file in the offices of the PHA/IHA and the Architect at least 7 days before bid opening.

4. Responsibility of Prospective Contractor

(a) The PHA/IHA will award contracts only to responsible prospective contractors who have the ability to perform successfully under the terms and conditions of the proposed contract. In determining the responsibility of a bidder, the PHA/IHA will consider such matters as the bidder's:

- (1) Integrity;
- (2) Compliance with public policy;
- (3) Record of past performance; and
- (4) Financial and technical resources (including construction and technical equipment).

(b) Before a bid is considered for award, the bidder may be requested by the PHA/IHA to submit a statement or other documentation regarding any of the items in paragraph (a) above. Failure by the bidder to provide such additional information shall render the bidder nonresponsible and ineligible for award.

5. Late Submissions, Modifications, and Withdrawal of Bids

(a) Any bid received at the place designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before award is made and it:

(1) Was sent by registered or certified mail not later than the fifth calendar day before the date specified for receipt of offers (e.g., an offer submitted in response to a solicitation requiring receipt of offers by the 20th of the month must have been mailed by the 15th);

(2) Was sent by mail, or if authorized by the solicitation, was sent by telegram or via facsimile, and it is determined by the PHA/IHA that the late receipt was due solely to mishandling by the PHA/IHA after receipt at the PHA/IHA; or

(3) Was sent by U.S. Postal Service Express Mail Next Day Service - Post Office to Addressee, not later than 5:00 p.m. at the place of mailing two working days prior to the date specified for receipt of proposals. The term "working days" excludes weekends and observed holidays.

(b) Any modification or withdrawal of a bid is subject to the same conditions as in paragraph (a) of this provision.

(c) The only acceptable evidence to establish the date of mailing of a late bid, modification, or withdrawal sent either by registered or certified mail is the U.S. or Canadian Postal Service postmark both on the envelope or wrapper and on the original receipt from the U.S. or Canadian Postal Service. Both postmarks must show a legible date or the bid, modification, or withdrawal shall be processed as if mailed late. "Postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed by employees of the U.S. or Canadian Postal Service on the date of mailing. Therefore, bidders should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper.

(d) The only acceptable evidence to establish the time of receipt at the PHA/IHA is the time/date stamp of PHA/IHA on the proposal wrapper or other documentary evidence of receipt maintained by the PHA/IHA.

(e) The only acceptable evidence to establish the date of mailing of a late bid, modification, or withdrawal sent by Express Mail Next Day Service-Post Office to Addressee is the date entered by the post office receiving clerk on the "Express Mail Next Day Service-Post Office to Addressee" label and the postmark on both the envelope or wrapper and on the original receipt from the U.S. Postal Service. "Postmark" has the same meaning as defined in paragraph (c) of this provision, excluding postmarks of the Canadian Postal Service. Therefore, bidders should request the postal clerk to place a legible hand cancellation bull's eye postmark on both the receipt and Failure by a bidder to acknowledge receipt of the envelope or wrapper.

(f) Notwithstanding paragraph (a) of this provision, a late modification of an otherwise successful bid that makes its terms more favorable to the PHA/IHA will be considered at any time it is received and may be accepted.

(g) Bids may be withdrawn by written notice, or if authorized by this solicitation, by telegram (including mailgram) or facsimile machine transmission received at any time before the exact time set for opening of bids; provided that written confirmation of telegraphic or facsimile withdrawals over the signature of the bidder is mailed and postmarked prior to the specified bid opening time. A bid may be withdrawn in person by a bidder or its authorized representative if, before the exact time set for opening of bids, the identity of the person requesting withdrawal is established and the person signs a receipt for the bid.

6. Bid Opening

All bids received by the date and time of receipt specified in the solicitation will be publicly opened and read. The time and place of opening will be as specified in the solicitation. Bidders and other interested persons may be present.

7. Service of Protest

(a) Definitions. As used in this provision:

"Interested party" means an actual or prospective bidder whose direct economic interest would be affected by the award of the contract.

"Protest" means a written objection by an interested party to this solicitation or to a proposed or actual award of a contract pursuant to this solicitation.

(b) Protests shall be served on the Contracting Officer by obtaining written and dated acknowledgement from —

[Contracting Officer designate the official or location where a protest may be served on the Contracting Officer]

(c) All protests shall be resolved in accordance with the PHA's/IHA's protest policy and procedures, copies of which are maintained at the PHA/IHA.

8. Contract Award

(a) The PHA/IHA will evaluate bids in response to this solicitation without discussions and will award a contract to the responsible bidder whose bid, conforming to the solicitation, will be most advantageous to the PHA/IHA considering only price and any price-related factors specified in the solicitation.

(b) If the apparent low bid received in response to this solicitation exceeds the PHA's/IHA's available funding for the proposed contract work, the PHA/IHA may either accept separately priced items (see 8(e) below) or use the following procedure to determine contract award. The PHA/IHA shall apply in turn to each bid (proceeding in order from the apparent low bid to the high bid) each of the separately priced bid deductible items, if any, in their priority order set forth in this solicitation. If upon the application of the first deductible item to all initial bids, a new low bid is within the PHA's/IHA's available funding, then award shall be made to that bidder. If no bid is within the available funding amount, then the PHA/IHA shall apply the second deductible item. The PHA/IHA shall continue this process until an evaluated low bid, if any, is within the PHA's/IHA's available funding. If upon the application of all deductibles, no bid is within the PHA's/IHA's available funding, or if the solicitation does not request separately priced deductibles, the PHA/IHA shall follow its written policy and procedures in making any award under this solicitation.

(c) In the case of tie low bids, award shall be made in accordance with the PHA's/IHA's written policy and procedures.

(d) The PHA/IHA may reject any and all bids, accept other than the lowest bid (e.g., the apparent low bid is unreasonably low), and waive informalities or minor irregularities in bids received, in accordance with the PHA's/IHA's written policy and procedures.

(e) Unless precluded elsewhere in the solicitation, the PHA/IHA may accept any item or combination of items bid.

(f) The PHA/IHA may reject any bid as nonresponsive if it is materially unbalanced as to the prices for the various items of work to be performed. A bid is materially unbalanced when it is based on prices significantly less than cost for some work and prices which are significantly overstated for other work.

(g) A written award shall be furnished to the successful bidder within the period for acceptance specified in the bid and shall result in a binding contract without further action by either party.

9. Bid Guarantee (applicable to construction and equipment contracts exceeding \$25,000)

All bids must be accompanied by a negotiable bid guarantee which shall not be less than five percent (5%) of the amount of the bid. The bid guarantee may be a certified check, bank draft, U.S. Government Bonds at par value, or a bid bond secured by a surety company acceptable to the U.S. Government and authorized to do business in the state where the work is to be performed. In the case where the work under the contract will be performed on an Indian reservation area, the bid guarantee may also be an irrevocable Letter of Credit (see provision 10, Assurance of Completion, below). Certified checks and bank drafts must be made payable to the order of the PHA/IHA. The bid guarantee shall insure the execution of the contract and the furnishing of a method of assurance of completion by the successful bidder as required by the solicitation. Failure to submit a bid guarantee with the bid shall result in the rejection of the bid. Bid guarantees submitted by unsuccessful bidders will be returned as soon as practicable after bid opening.

10. Assurance of Completion

(a) Unless otherwise provided in State law, the successful bidder shall furnish an assurance of completion prior to the execution of any contract under this solicitation. This assurance may be [Contracting Officer check applicable items] —

[] (1) a performance and payment bond in a penal sum of 100 percent of the contract price; or, as may be required or permitted by State law;

[] (2) separate performance and payment bonds, each for 50 percent or more of the contract price;

[] (3) a 20 percent cash escrow;

[] (4) a 25 percent irrevocable letter of credit; or,

[] (5) an irrevocable letter of credit for 10 percent of the total contract price with a monitoring and disbursements agreement with the IHA (applicable only to contracts awarded by an IHA under the Indian Housing Program).

(b) Bonds must be obtained from guarantee or surety companies acceptable to the U.S. Government and authorized to do business in the state where the work is to be performed. Individual sureties will not be considered. U.S. Treasury Circular Number 570, published annually in the Federal Register, lists companies approved to act as sureties on bonds securing Government contracts, the maximum underwriting limits on each contract bonded, and the States in which the company is licensed to do business. Use of companies listed in this circular is mandatory. Copies of the circular may be downloaded on the U.S. Department of Treasury website <http://www.fms.treas.gov/c570/index.html>, or ordered for a minimum fee by contacting the Government Printing Office at (202) 512-2168.

(c) Each bond shall clearly state the rate of premium and the total amount of premium charged. The current power of attorney for the person who signs for the surety company must be attached to the bond. The effective date of the power of attorney shall not precede the date of the bond. The effective date of the bond shall be on or after the execution date of the contract.

(d) Failure by the successful bidder to obtain the required assurance of completion within the time specified, or within such extended period as the PHA/IHA may grant based upon reasons determined adequate by the PHA/IHA, shall render the bidder ineligible for award. The PHA/IHA may then either award the contract to the next lowest responsible bidder or solicit new bids. The PHA/IHA may retain the ineligible bidder's bid guarantee.

11. Preconstruction Conference (applicable to construction contracts)

After award of a contract under this solicitation and prior to the start of work, the successful bidder will be required to attend a preconstruction conference with representatives of the PHA/IHA and its architect/engineer, and other interested parties convened by the PHA/IHA. The conference will serve to acquaint the participants with the general plan of the construction operation and all other requirements of the contract (e.g., Equal Employment Opportunity, Labor Standards). The PHA/IHA will provide the successful bidder with the date, time, and place of the conference.

12. Indian Preference Requirements (applicable only if this solicitation is for a contract to be performed on a project for an Indian Housing Authority)

(a) HUD has determined that the contract awarded under this solicitation is subject to the requirements of section 7(b) of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 450e(b)). Section 7(b) requires that any contract or subcontract entered into for the benefit of Indians shall require that, to the greatest extent feasible

(1) Preferences and opportunities for training and employment (other than core crew positions; see paragraph (h) below) in connection with the administration of such contracts or subcontracts be given to qualified "Indians." The Act defines "Indians" to mean persons who are members of an Indian tribe and defines "Indian tribe" to mean any Indian tribe, band, nation, or other organized group or community, including any Alaska Native village or regional or village corporation as defined in or established pursuant to the Alaska Native Claims Settlement Act, which is recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians; and,

(2) Preference in the award of contracts or subcontracts in connection with the administration of contracts be given to Indian organizations and to Indian-owned economic enterprises, as defined in section 3 of the Indian Financing Act of 1974 (25 U.S.C. 1452). That Act defines "economic enterprise" to mean any Indian-owned commercial, industrial, or business activity established or organized for the purpose of profit, except that the Indian ownership must constitute not less than 51 percent of the enterprise; "Indian organization" to mean the governing body of any Indian tribe or entity established or recognized by such governing body; "Indian" to mean any person who is a member of any tribe, band, group, pueblo, or community which is recognized by the Federal Government as eligible for services from the Bureau of Indian Affairs and any "Native" as defined in the Alaska Native Claims Settlement Act; and Indian "tribe" to mean any Indian tribe, band, group, pueblo, or community including Native villages and Native groups (including

corporations organized by Kenai, Juneau, Sitka, and Kodiak) as defined in the Alaska Native Claims Settlement Act, which is recognized by the Federal Government as eligible for services from the Bureau of Indian Affairs.

(b) (1) The successful Contractor under this solicitation shall comply with the requirements of this provision in awarding all subcontracts under the contract and in providing training and employment opportunities.

(2) A finding by the IHA that the contractor, either (i) awarded a subcontract without using the procedure required by the IHA, (ii) falsely represented that subcontracts would be awarded to Indian enterprises or organizations; or, (iii) failed to comply with the contractor's employment and training preference bid statement shall be grounds for termination of the contract or for the assessment of penalties or other remedies.

(c) If specified elsewhere in this solicitation, the IHA may restrict the solicitation to qualified Indian-owned enterprises and Indian organizations. If two or more (or a greater number as specified elsewhere in the solicitation) qualified Indian-owned enterprises or organizations submit responsive bids, award shall be made to the qualified enterprise or organization with the lowest responsive bid. If fewer than the minimum required number of qualified Indian-owned enterprises or organizations submit responsive bids, the IHA shall reject all bids and readvertise the solicitation in accordance with paragraph (d) below.

(d) If the IHA prefers not to restrict the solicitation as described in paragraph (c) above, or if after having restricted a solicitation an insufficient number of qualified Indian enterprises or organizations submit bids, the IHA may advertise for bids from non-Indian as well as Indian-owned enterprises and Indian organizations. Award shall be made to the qualified Indian enterprise or organization with the lowest responsive bid if that bid is -

(1) Within the maximum HUD-approved budget amount established for the specific project or activity for which bids are being solicited; and

(2) No more than the percentage specified in 24 CFR 905.175(c) higher than the total bid price of the lowest responsive bid from any qualified bidder. If no responsive bid by a qualified Indian-owned economic enterprise or organization is within the stated range of the total bid price of the lowest responsive bid from any qualified enterprise, award shall be made to the bidder with the lowest bid.

(e) Bidders seeking to qualify for preference in contracting or subcontracting shall submit proof of Indian ownership with their bids. Proof of Indian ownership shall include but not be limited to:

(1) Certification by a tribe or other evidence that the bidder is an Indian. The IHA shall accept the certification of a tribe that an individual is a member.

(2) Evidence such as stock ownership, structure, management, control, financing and salary or profit sharing arrangements of the enterprise.

(f) (1) All bidders must submit with their bids a statement describing how they will provide Indian preference in the award of subcontracts. The specific requirements of that statement and the factors to be used by the IHA in determining the statement's adequacy are included as an attachment to this solicitation. Any bid that fails to include the required statement shall be rejected as nonresponsive. The IHA may require that comparable statements be provided by subcontractors to the successful Contractor, and may require the Contractor to reject any bid or proposal by a subcontractor that fails to include the statement.

(2) Bidders and prospective subcontractors shall submit a certification (supported by credible evidence) to the IHA in any instance where the bidder or subcontractor believes it is infeasible to provide Indian preference in subcontracting. The acceptance or rejection by the IHA of the certification shall be final. Rejection shall disqualify the bid from further consideration.

(g) All bidders must submit with their bids a statement detailing their employment and training opportunities and their plans to provide preference to Indians in implementing the contract; and the number or percentage of Indians anticipated to be employed and trained. Comparable statements from all proposed subcontractors must be submitted. The criteria to be used by the IHA in determining the statement(s)'s adequacy are included as an attachment to this solicitation. Any bid that fails to include the required statement(s), or that includes a statement that does not meet minimum standards required by the IHA shall be rejected as nonresponsive.

(h) Core crew employees. A core crew employee is an individual who is a bona fide employee of the contractor at the time the bid is submitted; or an individual who was not employed by the bidder at the time the bid was submitted, but who is regularly employed by the bidder in a supervisory or other key skilled position when work is available. Bidders shall submit with their bids a list of all core crew employees.

(i) Preference in contracting, subcontracting, employment, and training shall apply not only on-site, on the reservation, or within the IHA's jurisdiction, but also to contracts with firms that operate outside these areas (e.g., employment in modular or manufactured housing construction facilities).

(j) Bidders should contact the IHA to determine if any additional local preference requirements are applicable to this solicitation.

(k) The IHA [] does [] does not [Contracting Officer check applicable box] maintain lists of Indian-owned economic enterprises and Indian organizations by specialty (e.g., plumbing, electrical, foundations), which are available to bidders to assist them in meeting their responsibility to provide preference in connection with the administration of contracts and subcontracts.

SECTION 00300

BID SUBMISSION FORMS

Please complete and submit all pages to page titled "**End of Bid Forms**"
and any Addendum Receipt issued for this project

BID FORM
#25-C-0019
HEERAN CENTER HVAC SYSTEM UPGRADE

1. The undersigned, having familiarized them self (or themselves) with the local conditions affecting the cost of the work, and with the Specifications (including, Instructions to Bidders, the form of Representations, Certifications and Other Statements, this bid, the form of Non-Collusive Affidavit, the form of Contract, the General and Special Conditions, the Description of the Work, the Specifications and Drawing(s) and Addenda, if any thereto, as prepared by Homes for Good Housing Agency and on file in the office of Homes for Good Housing Agency, 100 W. 13th Avenue, Eugene, Oregon 97401, hereby proposes to furnish all labor, equipment, and materials for the **Heeran Center HVAC System Upgrade** project.

<p>FOR THE TOTAL BASIC BID OF</p> <p>\$ _____</p> <hr style="border: 0.5px solid black;"/> <p style="text-align: center;">(WRITE OUT)</p>
--

2. In submitting this bid, it is understood that the right is reserved by the Homes for Good Housing Agency to reject any and all bids. If written notice of the acceptance of this bid is mailed, telegraphed or delivered to the undersigned within 30 days after the opening thereof, or at any time thereafter before this bid is withdrawn, the undersigned agrees to execute and deliver a contract in the prescribed form and furnish the required bond within ten (10) days after the contract is presented to him for signature.
3. (5% Bid Security): Security in the sum of 5% of Bid Amount in the form of (form included) is submitted herewith in accordance with the Specifications.
4. Attached hereto is an affidavit in proof that the undersigned has not entered into any collusion with any person in respect to this proposal or any other proposal or the submitting of proposals for the contract for which this proposal is submitted.
5. The bidder represents that **they [] have, [] have not**, participated in a previous contract or subcontract subject to the equal opportunity clause prescribed by Executive Orders 10925, 11114, or 11246 or the Secretary of Labor; that he [] has, [] has not, filed all required compliance reports; and that representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained prior to subcontract awards. (The above representation need not be submitted in connection with contracts or subcontracts which are exempt from the clause).
6. Certification of Non-Segregated Facilities. By signing this bid, the bidder certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The bidder agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for

employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding \$10,000 which are not exempt from the provisions of the Equal Opportunity clause; that he will retain such certifications in his files; and that he will forward a notice to his proposed subcontractors as provided in the instruction to bidders.

- 7. Drug Free Environment Certification: By signing this bid, the bidder certifies that he will, or will continue to, provide a drug-free workplace while performing work at the contracted location, and will adhere and perform to the directions stipulated in the Special Conditions, item 18, Drug Free Work Place Requirement.

Note: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

BID SUBMITTED BY:

NAME OF BIDDER (COMPANY): _____

BY (PRINT NAME): _____

TITLE: _____

SIGNATURE: _____ DATE: _____
(SIGN ORIGINAL ONLY)

COMPANY OFFICIAL STREET ADDRESS: _____

CITY: _____ STATE: _____ ZIP CODE: _____

COMPANY FEDERAL ID #: _____ PHONE: (____) _____

CONTRACTOR'S BOARD REGISTRATION: NUMBER: _____

CATEGORY/TYPE: _____

EXPIRATION DATE: _____

NOTARY

TO CERTIFY SIGNATURE.

SUBSCRIBED AND SWORN to before me this _____ day of _____, 20____.
(Stamp or seal 📌)

Notary Public for Oregon

My Commission Expires: _____

NOTE: COMPLETE AND SUBMIT THIS FORM WITH BID

INDEPENDENT CONTRACTOR CERTIFICATION STATEMENT

NOTE: Oregon law, ORS 701.075, requires your business to qualify as an independent contractor (demonstrate that you are in business for yourself and not an employee) in order to be registered with the Construction Contractors Board (formerly called the Builders Board).

You can qualify as an independent contractor by certifying that you meet all the following standards as required by ORS chapters 310, 316, 656, 657, 670 and 701;

- (1) You provide labor and services free from direction and control, subject only to the accomplishment of specified results.
- (2) You are responsible for obtaining all assumed business registrations or professional occupation licenses required by state or local law.
- (3) You furnish the tools or equipment necessary to do the work.
- (4) You have the authority to hire and fire employees to perform the work.
- (5) You are paid on completion of the project or on the basis of a periodic retainer.
- (6) You are registered with the Construction Contractors Board (as required).
- (7) You filed Federal and state income tax returns for the business for the previous year if you performed labor or services as an independent contractor in the previous year.
- (8) You represent to the public that you are an independently established business, by **indicating that you meet four (4) or more of the following:**

- _____ A) You work primarily at a location separate from your residence.
- _____ B) You have purchased commercial advertising, business cards, or have a trade association membership.
- _____ C) You use a telephone listing and service separate from you personal residence listing and service.
- _____ D) You perform labor or services only pursuant to written contracts.
- _____ E) You perform labor or services for two or more different persons within a period of one year.
- _____ F) You assume financial responsibility for defective workmanship and breach of contract, as evidenced by performance bonds or liability insurance coverage.

I hereby certify that the above information is correct.

SIGNATURE: _____ DATE: _____
(OWNER, PARTNER OR CORPORATE OFFICER)

ENTITY: _____

SIGNATURE: _____ DATE: _____
(COMPANY OR CORPORATION NAME)

ATTENTION: THIS PAGE MUST BE SIGNED AND SUBMITTED WITH BID.

CERTIFICATION OF INFORMALITIES OR IRREGULARITIES

By signature below Bidder accepts the right of the Agency to reject any or all bids and waive informalities or irregularities.

NAME OF COMPANY: _____

MAILING AND BUSINESS LOCATION ADDRESSES:

INDICATE THE TYPE OF FIRM SUBMITTING THIS BID BY MARKING THE APPROPRIATE LINE BELOW.

Bid is by a Sole Proprietorship. Bid is signed by the individual.

Bid is by a Partnership. Bid is signed by one of the Partners.

Bid is by a Corporation. The Corporate Seal is affixed at right and the signature is that of a current officer or authorized representative.

CORPORATE SEAL (IF AVAILABLE)

SIGNATURE: _____

BY: _____
(PLEASE PRINT NAME)

TITLE: _____ DATE: _____

ATTENTION: THIS PAGE MUST BE SIGNED AND SUBMITTED WITH BID.

FORM OF NON-COLLUSIVE AFFIDAVIT

State of OREGON)ss.

County of LANE)

_____, being first duly sworn, deposes and says:

That he/she is _____ (a partner or the officer of the firm of, etc.)
the party making the foregoing proposal or bid, that such proposal or bid is genuine and not collusive or sham; that said bidder has not colluded, conspired, connived or agreed, directly or indirectly, with any bidder or person, to put in a sham bid or to refrain from bidding, and has not in any manner, directly or indirectly, sought by agreement or collusion, or communication or conference, with any person, to fix the bid price of affiant or of any other bidder, or to fix any overhead, profit or cost element of said bid price, or of that of any other bidder, or to secure any advantage against the Homes for Good Housing Agency or any person interested in the proposed contract; and that all statements in said proposal or bid are true.

COMPANY NAME: _____

SIGNATURE: _____

SIGNATURE BY PERSON SIGNING ABOVE SHOULD BE:

- BY INDIVIDUAL IF BID IS BY A SOLE PROPRIETORSHIP
- BY ONE OF THE PARTNERS IF BID IS BY A PARTNERSHIP
- BY A CURRENT OFFICER OR AUTHORIZED REPRESENTATIVE IF BID IS BY A CORPORATION.

NOTE: COMPLETE AND SUBMIT THIS FORM WITH BID.

SECTION 3 CERTIFICATION FORM

INSTRUCTIONS. In order for Homes for Good to meet the requirements of Section 3, each contractor is asked to certify whether or not they are a Section 3 business concern. The following information will assist in making that determination. After reviewing the information, please complete the certification at the bottom of the page which states that you are or are not a Section 3 Contractor.

Section 3 of the Housing and Urban Development Act of 1968 states that, to the greatest extent feasible, opportunities for training and employment should be given to very low/low-income residents of the HUD-assisted project area. In the case of a Section 3 Certified business, should a job opening occur as a result of this contract, "a good faith effort" must be made to hire and/or train lower-income persons.

A SECTION 3 RESIDENT MEANS:

- A Public Housing resident
- An Individual who resides in the project area (Lane County) in which the Section 3 covered assistance is expended, and who is "low income" or "very low-income".
- The easiest way to find out if an applicant qualifies as a Section 3 resident is to ask them to certify that they are a public housing resident or are living in the Section 3 area and their family is low/very low income.

A SECTION 3 BUSINESS CONCERN MEANS:

- If it is 51 percent or more owned by Section 3 residents; or
- A company whose permanent, full-time employees (do not count part-time employees) include persons, at least 30 percent of whom are currently Section 3 residents, or within three years of the date of first employment with the business concern were Section 3 residents; or
- A company that provides evidence of a commitment to subcontract in excess of 25 percent of total dollar awarded of all subcontracts to be awarded to business concerns that meet the above qualifications.

HAVING READ THE SECTION 3 CLAUSE, I HEREBY CERTIFY THAT **I AM [] OR AM NOT []** A SECTION 3 BUSINESS CONCERN AND THAT **I WILL [] OR WILL NOT []** TAKE STEPS TO THE "GREATEST EXTENT FEASIBLE" TO OFFER TRAINING AND EMPLOYMENT OPPORTUNITIES THAT MAY ARISE FROM THIS PROJECT TO SECTION 3 RESIDENTS:

NAME OF COMPANY: _____

NAME OF SIGNER: _____
(PLEASE PRINT)

SIGNATURE: _____

STATE OF OREGON

FIRST-TIER SUBCONTRACTOR DISCLOSURE FORM

PROJECT NAME: HEERAN CENTER HVAC SYSTEM UPGRADE

BID CLOSING: TUESDAY, APRIL 15, 2025, AT 2 PM

This form must be submitted at the location specified in the Notice to Contractors, due within 2 hours after the date and time of the deadline when bids are due.

List below the name of each subcontractor that will be furnishing labor or materials and that is required to be disclosed by ORS279.C.370. List the dollar value of the subcontract and the category of work that the subcontractor will be performing.

Enter "**NONE**" if there are no subcontractors that need to be disclosed. (ATTACH ADDITIONAL SHEETS IF NEEDED.)

NAME OF SUB-CONTRACTOR	DOLLAR VALUE	CATEGORY/DIVISION OF WORK (Painting, electrical, landscaping, etc.)
	\$	
	\$	
	\$	
	\$	
	\$	
	\$	
	\$	
	\$	
	\$	
	\$	

FAILURE TO SUBMIT THIS FORM BY DISCLOSURE DEADLINE WILL RESULT IN A NON-RESPONSIVE BID. A NON-RESPONSIVE BID WILL NOT BE CONSIDERED FOR AWARD.

FORM SUBMITTED BY: _____ DATE: _____

HOMES FOR GOOD HOUSING AGENCY
100 W. 13th Avenue, Eugene, Oregon 97401

SUBMIT WITH BID IF ADDENDA ISSUED.

ADDENDUM RECEIPT

FOR PROJECT # _____

TITLED: _____

ADDENDA NUMBERED: _____ DATED: _____

WITH PAGES NUMBERED _____ THROUGH _____

BY MY SIGNATURE BELOW I ACKNOWLEDGE:

- receipt of the noted addendum,
- that it has been fully reviewed, and
- that all terms included therein are acceptable.

SIGNATURE: _____

TITLE: _____ DATE: _____

COMPLETE THIS FORM AND SUBMIT WITH BID DOCUMENTS – IF ANY ADDENDA HAVE BEEN ISSUED

All bidders must complete and sign this form for each Addendum issued. The form is to be submitted with the bid documents. A bid will be considered non-responsive if a completed Addendum Receipt is not submitted with the bid, for each addendum issued.

BID BOND

KNOW ALL MEN BY THESE PRESENTS, That we the undersigned,

_____ as **PRINCIPAL**, and
(Name of Principal)

_____ as **SURETY**,
(Name of Surety)

are held and firmly bound unto Homes for Good Housing Agency in the penal sum of \$ _____

Dollars, lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has submitted the accompanying bid, dated _____, 20____, for _____

_____.

NOW, THEREFORE, if the Principal shall not withdraw said bid within the period specified therein after the opening of the same, or, if no period be specified, within sixty (60) days after the said opening, and shall within the period specified therefore, or if no period be specified within ten (10) days after the prescribed forms are presented to him for signature, enter into a written contract with Homes for Good Housing Agency in accordance with the bid as accepted, and give bond with good and sufficient surety or sureties, as may be required, for the faithful performance and proper fulfillment of such contract; or in the event of the withdrawal of said bid within the period specified, or the failure to enter into such contract and give such bond within the time specified, if the Principal shall pay Homes for Good Housing Agency the difference between the amount specified in said bid and the amount for which Homes for Good Housing Agency may procure the required work or supplies or both, if the latter amount be in excess of the former, then the above obligation shall be void and of no effect, otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bonded parties have executed this instrument under their several seals this _____ day of _____, 20 ____, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

IN THE PRESENCE OF:

(AFFIX SEAL)
If available.

ATTEST: INDIVIDUAL PRINCIPAL

BY: _____

Business Address: _____

ATTEST: CORPORATE PRINCIPAL

(AFFIX SEAL)
If available. BYBY

BY: _____

Business Address: _____

ATTEST: CORPORATE SURETY

(AFFIX SEAL)
If available.

BY: _____

Business Address: _____

CERTIFICATE AS TO CORPORATE PRINCIPAL

I, _____, certify that I am the _____ of the corporation named as Principal in the within bond; that _____ who signed the said bond on behalf of the Principal was then _____ of said corporation; that I know his signature, and his signature thereto is genuine, and that said bond was duly signed, sealed, and attested to for and in behalf of said corporation by authority of its governing body.

Signature _____

(CORPORATE SEAL)

NOTE: POWER-OF-ATTORNEY FOR PERSON SIGNING FOR SURETY COMPANY MUST BE ATTACHED TO BOND.

SECTION 00600 & 00610

BOND FORMS

As stipulated by the State of Oregon regulations
Separate Bonds are required for

100 % PERFORMANCE BOND
&
100% PAYMENT BOND

When contract equals or exceeds \$100,000.00
the bond forms of this section are to be used for submission of the *two*
bonds at the time the awarded bidder submits signed contracts.

Surety: Use these forms and attach a power of attorney.

*See Instructions to Bidders for other Performance Guarantee Options
Bonds are due to Homes for Good with the signed contract.*

PAYMENT BOND

For Homes for Good Housing Agency

KNOW ALL MEN BY THESE PRESENTS: That we

_____ (NAME OF CONTRACTOR)
as principal, and _____ (SURETY)

a corporation organized and existing under and by virtue of the laws of the State of

_____ and duly authorized to transact surety business in the State of Oregon, as surety, are jointly and

severally held and bound unto Homes for Good Housing Agency hereinafter called the "Owner", in the sum of _____ (\$ _____), for the payment of which we jointly and severally bind ourselves, our heirs, executors, administrators and assigns or successors and assigns, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that Whereas, the Principal has made and entered into a certain contract, a copy of which is attached hereto, with the Owner, which contract, together with the applicable plans, specifications, provisions, and schedule of contract prices, is by this reference made a part, whereby the principal agrees to perform in accordance with certain terms, conditions, requirements, plans and specifications which are set out in the contract and all authorized amendments or modifications of the contract. Provided that it is expressly agreed that the Bond shall be deemed amended automatically and immediately, without formal and separate amendments hereto, upon amendment to the Contract so as to bind the Principal, and the Surety to the full and faithful performance of the Contract as so amended.

NOW, THEREFORE, if the principal shall make payment promptly, as due to all subcontractors and to all persons supplying to the Contractor or its subcontractors, equipment, supplies, labor and materials for the prosecution of the work, or any part thereof, provided for in said contract, and shall in performing the contract pay and cause to be paid not less than the applicable (Davis Bacon Wage Rate or State of Oregon Bureau of Labor and Industries Wage Rate) prevailing wage rates in effect as of the date of the bid, per hour, day and week for and to each and every worker who may be employed in and about the performance of the contract and shall pay all contribution of amounts due for workers' compensation and all amounts due the State Unemployment Compensation Trust Fund from such Contractor or subcontractors incurred in the performance of said contract, and pay all sums of money withheld from the Contractor's employees and payable to the State Department of Revenue, and shall pay all other just debts, dues demands incurred in the performance of the said contract and shall pay the Owner such damages as may accrue to the Owner under the contract, then this obligation is to be void, otherwise to remain in full force and effect, provided that surety will remain liable to satisfy the claim of any worker affected by the failure of the principal or any subcontractor under the contract to pay the minimum rate of wage in accordance with the contract in the amount of the unpaid minimum wages and an additional amount equal thereto as liquidated damages.

Non payment of the bond premium will not invalidate this bond nor shall the Owner, be obligated for the payment thereof.

This Bond is given and received under the authority of ORS Chapter 279, the provisions of which relating to performance bonds are incorporated into this Bond by reference.

(SURETY)

The rate of premium on this bond is \$ _____ per thousand.

The total amount of premium charged is \$ _____ .

(The above is to be filled in by surety company, and the power of attorney of person signing for the surety company must be attached)

Witness our hands this _____ Day of _____ , 2025

Corporate Seal

PRINCIPAL

By _____
Authorized Official Signature

By _____
Authorized Official Signature

PRINCIPAL

By _____
Authorized Official Signature

By _____
Authorized Official Signature

Surety' Seal Must Be Affixed

SURETY

By _____
Attorney in Fact

(A power of Attorney for the Attorney in Fact must be attached to this bond)

By _____
Agent

PERFORMANCE BOND

HOMES FOR GOOD HOUSING AGENCY

KNOW ALL MEN BY THESE PRESENTS: That

we _____ (NAME OF CONTRACTOR)

as principal, and _____
(SURETY)

a corporation organized and existing under and by virtue of the laws of the State of _____ and duly authorized to transact surety business in the State of Oregon, as surety, are jointly and severally held and bound unto Homes for Good Housing Agency hereinafter called the "Owner", in the sum of _____, for the payment of which we jointly and severally bind ourselves, our heirs, executors, administrators and assigns or successors and assigns, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that Whereas, the Principal has made and entered into a certain contract, a copy of which is attached hereto, with the Owner, which contract, together with the applicable plans, specifications, provisions, and schedule of contract prices, is by this reference made a part, whereby the principal agrees to perform in accordance with certain terms, conditions, requirements, plans and specifications which are set out in the contract and all authorized amendments or modifications of the contract. Provided that it is expressly agreed that the Bond shall be deemed amended automatically and immediately, without formal and separate amendments hereto, upon amendment to the Contract so as to bind the Principal, and the Surety to the full and faithful performance of the Contract as so amended.

NOW, THEREFORE, if the principal shall faithfully and truly observe and comply with the terms, conditions and provisions of the contract, in all respects, and shall well and truly and fully do and perform all matters and things by it undertaken to be performed under the contract, upon the terms set forth and within the time prescribed therein, or as extended as provided in the contract, and agrees to indemnify, defend and hold the Owner, its Commissioners, agents, officers and employees harmless and defend all damages, losses and expenses including but not limited to attorney's fees and to defend all claims, proceedings, lawsuits and judgments arising out of or resulting from the fault of the principal, the principal's agents, representatives or subcontractors, in the performance of or failure to perform this contract. However, principal shall not be required to indemnify any indemnities to the extent the damage, loss or expense is caused by the indemnity's negligence and shall in all respects perform said contract according to law, then this obligation is to be void, otherwise to remain in full force and effect.

Non payment of the bond premium will not invalidate this bond nor shall the Owner, be obligated for the payment thereof.

This Bond is given and received under the authority of ORS Chapter 279, the provisions of which relating to performance bonds are incorporated into this Bond by reference.

(SURETY)

The rate of premium on this bond is \$ _____ per thousand.

The total amount of premium charged is \$ _____ .

(The above is to be filled in by surety company, and the power of attorney of person signing for the surety company must be attached)

Witness our hands this _____ Day of _____ , 2025

Corporate Seal

PRINCIPAL

By _____
Authorized Official Signature

By _____
Authorized Official Signature

PRINCIPAL

By _____
Authorized Official Signature

By _____
Authorized Official Signature

Surety' Seal Must Be Affixed

SURETY

By _____
Attorney in Fact

(A power of Attorney for the Attorney in Fact must be attached to this bond)

By _____
Agent

SECTION 00710

HUD-5370

**General Conditions
For Construction Contracts
Public Housing Programs**

Applicable to any construction contract greater than \$250,000.

General Conditions for Construction Contracts - Public Housing Programs

U.S. Department of Housing and Urban
Development
Office of Public and Indian Housing
OMB Approval No. 2577-0157 (exp. 1/31/2027)

**Applicability. This form is applicable to any
construction/development contract greater than \$250,000.**

Public reporting burden for this collection of information is estimated to average 1.0 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Comments regarding the accuracy of this burden estimate and any suggestions for reducing this burden can be sent to the Reports Management Officer, Office of Policy Development and Research, REE, Department of Housing and Urban Development, 451 7th St SW, Room 4176, Washington, DC 20410-5000. When providing comments, please refer to OMB Approval No. 2577-0157. This form includes those clauses required by OMB's common rule on grantee procurement, implemented at HUD in 2 CFR 200, and those requirements set forth in Section 3 of the Housing and Urban Development Act of 1968 and its amendment by the Housing and Community Development Act of 1992, implemented by HUD at 24 CFR Part 75. The form is required for construction contracts awarded by Public Housing Agencies (PHAs). The form is used by Housing Authorities in solicitations to provide necessary contract clauses. If the form were not used, PHAs would be unable to enforce their contracts. Responses to the collection of information are required to obtain a benefit or to retain a benefit. The information requested does not lend itself to confidentiality. HUD may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB number.

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1. Definitions

- (a) "Architect" means the person or other entity engaged by the PHA to perform architectural, engineering, design, and other services related to the work as provided for in the contract. When a PHA uses an engineer to act in this capacity, the terms "architect" and "engineer" shall be synonymous. The Architect shall serve as a technical representative of the Contracting Officer. The Architect's authority is as set forth elsewhere in this contract.
- (b) "Contract" means the contract entered into between the PHA and the Contractor. It includes the forms of Bid, the Bid Bond, the Performance and Payment Bond or Bonds or other assurance of completion, the Certifications, Representations, and Other Statements of Bidders (form HUD-5370), these General Conditions of the Contract for Construction (form HUD-5370), the applicable wage rate determinations from the U.S. Department of Labor, any special conditions included elsewhere in the contract, the specifications, and drawings. It includes all formal changes to any of those documents by addendum, change order, or other modification.
- (c) "Contracting Officer" means the person delegated the authority by the PHA to enter into, administer, and/or terminate this contract and designated as such in writing to the Contractor. The term includes any successor Contracting Officer and any duly authorized representative of the Contracting Officer also designated in writing. The Contracting Officer shall be deemed the authorized agent of the PHA in all dealings with the Contractor.
- (d) "Contractor" means the person or other entity entering into the contract with the PHA to perform all of the work required under the contract.
- (e) "Drawings" means the drawings enumerated in the schedule of drawings contained in the Specifications and as described in the contract clause entitled Specifications and Drawings for Construction herein.
- (f) "HUD" means the United States of America acting through the Department of Housing and Urban Development including the Secretary, or any other person designated to act on its behalf. HUD has agreed, subject to the provisions of an Annual Contributions Terms and Conditions (ACC), to provide financial assistance to the PHA, which includes assistance in financing the work to be performed under this contract. As defined elsewhere in these General Conditions or the contract documents, the determination of HUD may be required to authorize changes in the work or for release of funds to the PHA for payment to the Contractor. Notwithstanding HUD's role, nothing in this contract shall be construed to create any contractual relationship between the Contractor and HUD.
- (g) "Project" means the entire project, whether construction or rehabilitation, the work for which is provided for in whole or in part under this contract.
- (h) "PHA" means the Public Housing Agency organized under applicable state laws which is a party to this contract.
- (j) "Specifications" means the written description of the technical requirements for construction and includes the criteria and tests for determining whether the requirements are met.
- (l) "Work" means materials, workmanship, and manufacture and fabrication of components.

2. Contractor's Responsibility for Work

- (a) The Contractor shall furnish all necessary labor, materials, tools, equipment, and transportation necessary for performance of the work. The Contractor shall also furnish all necessary water, heat, light, and power not made available to the Contractor by the PHA pursuant to the clause entitled Availability and Use of Utility Services herein.
- (b) The Contractor shall perform on the site, and with its own organization, work equivalent to at least [] (12 percent unless otherwise indicated) of the total amount of work to be performed under the order. This percentage may be reduced by a supplemental agreement to this order if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the PHA.
- (c) At all times during performance of this contract and until the work is completed and accepted, the Contractor shall directly superintend the work or assign and have on the work site a competent superintendent who is satisfactory to the Contracting Officer and has authority to act for the Contractor.
- (d) The Contractor shall be responsible for all damages to persons or property that occur as a result of the Contractor's fault or negligence, and shall take proper safety and health precautions to protect the work, the workers, the public, and the property of others. The Contractor shall hold and save the PHA, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the entire work, except for any completed unit of work which may have been accepted under the contract.
- (e) The Contractor shall lay out the work from base lines and bench marks indicated on the drawings and be responsible for all lines, levels, and measurements of all work executed under the contract. The Contractor shall verify the figures before laying out the work and will be held responsible for any error resulting from its failure to do so.
- (f) The Contractor shall confine all operations (including storage of materials) on PHA premises to areas authorized or approved by the Contracting Officer.
- (g) The Contractor shall at all times keep the work area, including storage areas, free from accumulations of waste materials. After completing the work and before final inspection, the Contractor shall (1) remove from the premises all scaffolding, equipment, tools, and materials (including rejected materials) that are not the property of the PHA and all rubbish caused by its work; (2) leave the work area in a clean, neat, and orderly condition satisfactory to the Contracting Officer; (3) perform all specified tests; and, (4) deliver the installation in complete and operating condition.
- (h) The Contractor's responsibility will terminate when all work has been completed, the final inspection made, and the work accepted by the Contracting Officer. The Contractor will then be released from further obligation except as required by the warranties specified elsewhere in the contract.

3. Architect's Duties, Responsibilities, and Authority

- (a) The Architect for this contract, and any successor, shall be designated in writing by the Contracting Officer.

- (b) The Architect shall serve as the Contracting Officer's technical representative with respect to architectural, **Schedule** engineering, and design matters related to the work performed under the contract. The Architect may provide direction on contract performance. Such direction shall be within the scope of the contract and may not be of a nature which: (1) institutes additional work outside the scope of the contract; (2) constitutes a change as defined in the Changes clause herein; (3) causes an increase or decrease in the cost of the contract; (4) alters the Construction Progress Schedule; or (5) changes any of the other express terms or conditions of the contract.
- (c) The Architect's duties and responsibilities may include but shall not be limited to:
- (1) Making periodic visits to the work site, and on the basis of his/her on-site inspections, issuing written reports to the PHA which shall include all observed deficiencies. The Architect shall file a copy of the report with the Contractor's designated representative at the site;
 - (2) Making modifications in drawings and technical specifications and assisting the Contracting Officer in the preparation of change orders and other contract modifications for issuance by the Contracting Officer;
 - (3) Reviewing and making recommendations with respect to - (i) the Contractor's construction progress schedules; (ii) the Contractor's shop and detailed drawings; (iii) the machinery, mechanical and other equipment and materials or other articles proposed for use by the Contractor; and, (iv) the Contractor's price breakdown and progress payment estimates; and,
 - (4) Assisting in inspections, signing Certificates of Completion, and making recommendations with respect to acceptance of work completed under the contract.

4. Other Contracts

The PHA may undertake or award other contracts for additional work at or near the site of the work under this contract. The Contractor shall fully cooperate with the other contractors and with PHA employees and shall carefully adapt scheduling and performing the work under this contract to accommodate the additional work, heeding any direction that may be provided by the Contracting Officer. The Contractor shall not commit or permit any act that will interfere with the performance of work by any other contractor or by PHA employees

Construction Requirements

5. Pre-construction Conference and Notice to Proceed

of the work, and that it has investigated and satisfied itself

- (a) Within ten calendar days of contract execution, and prior to the commencement of work, the Contractor shall attend a preconstruction conference with representatives of the PHA, its Architect, and other interested parties convened by the PHA. The conference will serve to acquaint the participants with the general plan of the construction operation and all other requirements of the contract. The PHA will provide the Contractor with the date, time, and place of the conference.
- (b) The contractor shall begin work upon receipt of a written Notice to Proceed from the Contracting Officer or designee. The Contractor shall not begin work prior to receiving such notice.

6. Construction Progress

- (a) The Contractor shall, within five days after the work commences on the contract or another period of time determined by the Contracting Officer, prepare and submit to the Contracting Officer for approval three copies of a practicable schedule showing the order in which the Contractor proposes to perform the work, and the dates on which the Contractor contemplates starting and completing the several salient features of the work (including acquiring labor, materials, and equipment). The schedule shall be in the form of a progress chart of suitable scale to indicate appropriately the percentage of work scheduled for completion by any given date during the period. If the Contractor fails to submit a schedule within the time prescribed, the Contracting Officer may withhold approval of progress payments or take other remedies under the contract until the Contractor submits the required schedule.
- (b) The Contractor shall enter the actual progress on the chart as required by the Contracting Officer, and immediately deliver three copies of the annotated schedule to the Contracting Officer. If the Contracting Officer determines, upon the basis of inspection conducted pursuant to the clause entitled Inspection and Acceptance of Construction, herein that the Contractor is not meeting the approved schedule, the Contractor shall take steps necessary to improve its progress, including those that may be required by the Contracting Officer, without additional cost to the PHA. In this circumstance, the Contracting Officer may require the Contractor to increase the number of shifts, overtime operations, days of work, and/or the amount of construction plant, and to submit for approval any supplementary schedule or schedules in chart form as the Contracting Officer deems necessary to demonstrate how the approved rate of progress will be regained.
- (c) Failure of the Contractor to comply with the requirements of the Contracting Officer under this clause shall be grounds for a determination by the Contracting Officer that the Contractor is not prosecuting the work with sufficient diligence to ensure completion within the time specified in the Contract. Upon making this determination, the Contracting Officer may terminate the Contractor's right to proceed with the work, or any separable part of it, in accordance with the Default clause of this contract.

7. Site Investigation and Conditions Affecting the Work

- (a) The Contractor acknowledges that it has taken steps reasonably necessary to ascertain the nature and location as to the general and local conditions which can affect the work or its cost, including but not limited to, (1) conditions bearing upon transportation, disposal, handling, and storage of materials; (2) the availability of labor, water, electric power, and roads; (3) uncertainties of weather, river stages, tides, or similar physical conditions at the site; (4) the conformation and conditions of the ground; and (5) the character of equipment and facilities needed preliminary to and during work performance. The Contractor also acknowledges that it has satisfied itself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is

reasonably ascertainable from an inspection of the site, including all exploratory work done by the PHA, as well as from the drawings and specifications made a part of this contract. Any failure of the Contractor to take the actions described and acknowledged in this paragraph will not relieve the Contractor from responsibility for estimating properly the difficulty and cost of successfully performing the work, or for proceeding to successfully perform the work without additional expense to the PHA.

(b) The PHA assumes no responsibility for any conclusions or interpretations made by the Contractor based on the information made available by the PHA. Nor does the PHA assume responsibility for any understanding reached or representation made concerning conditions which can affect the work by any of its officers or agents before the execution of this contract, unless that understanding or representation is expressly stated in this contract.

8. Differing Site Conditions

- (a) The Contractor shall promptly, and before the conditions are disturbed, give a written notice to the Contracting Officer of (1) subsurface or latent physical conditions at the site which differ materially from those indicated in this contract, or (2) unknown physical conditions at the site(s), of an unusual nature, which differ materially from those ordinarily encountered and generally recognized as inhering in work of the character provided for in the contract.
- (b) The Contracting Officer shall investigate the site conditions promptly after receiving the notice. Work shall not proceed at the affected site, except at the Contractor's risk, until the Contracting Officer has provided written instructions to the Contractor. If the conditions do materially so differ and cause an increase or decrease in the Contractor's cost of, or the time required for, performing any part of the work under this contract, whether or not changed as a result of the conditions, the Contractor shall file a claim in writing to the PHA within ten days after receipt of such instructions and, in any event, before proceeding with the work. An equitable adjustment in the contract price, the delivery schedule, or both shall be made under this clause and the contract modified in writing accordingly.
- (c) No request by the Contractor for an equitable adjustment to the contract under this clause shall be allowed, unless the Contractor has given the written notice required; provided, that the time prescribed in (a) above for giving written notice may be extended by the Contracting Officer.
- (d) No request by the Contractor for an equitable adjustment to the contract for differing site conditions shall be allowed if made after final payment under this contract.

9. Specifications and Drawings for Construction

- (a) The Contractor shall keep on the work site a copy of the drawings and specifications and shall at all times give the Contracting Officer access thereto. Anything mentioned in the specifications and not shown on the drawings, or shown on the drawings and not mentioned in the specifications, shall be of like effect as if shown or mentioned in both. In case of difference between drawings and specifications, the specifications shall govern. In case of discrepancy in the figures, in the drawings, or in the specifications, the matter shall be

promptly submitted to the Contracting Officer, who shall promptly make a determination in writing. Any adjustment by the Contractor without such a determination shall be at its own risk and expense. The Contracting Officer shall furnish from time to time such detailed drawings and other information as considered necessary, unless otherwise provided.

- (b) Wherever in the specifications or upon the drawings the words "directed", "required", "ordered", "designated", "prescribed", or words of like import are used, it shall be understood that the "direction", "requirement", "order", "designation", or "prescription", of the Contracting Officer is intended and similarly the words "approved", "acceptable", "satisfactory", or words of like import shall mean "approved by", or "acceptable to", or "satisfactory to" the Contracting Officer, unless otherwise expressly stated.
- (c) Where "as shown" "as indicated", "as detailed", or words of similar import are used, it shall be understood that the reference is made to the drawings accompanying this contract unless stated otherwise. The word "provided" as used herein shall be understood to mean "provide complete in place" that is "furnished and installed".
- (d) "Shop drawings" means drawings, submitted to the PHA by the Contractor, subcontractor, or any lower tier subcontractor, showing in detail (1) the proposed fabrication and assembly of structural elements and (2) the installation (i.e., form, fit, and attachment details) of materials of equipment. It includes drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials furnished by the Contractor to explain in detail specific portions of the work required by the contract. The PHA may duplicate, use, and disclose in any manner and for any purpose shop drawings delivered under this contract.
- (e) If this contract requires shop drawings, the Contractor shall coordinate all such drawings, and review them for accuracy, completeness, and compliance with other contract requirements and shall indicate its approval thereon as evidence of such coordination and review. Shop drawings submitted to the Contracting Officer without evidence of the Contractor's approval may be returned for resubmission. The Contracting Officer will indicate an approval or disapproval of the shop drawings and if not approved as submitted shall indicate the PHA's reasons therefore. Any work done before such approval shall be at the Contractor's risk. Approval by the Contracting Officer shall not relieve the Contractor from responsibility for any errors or omissions in such drawings, nor from responsibility for complying with the requirements of this contract, except with respect to variations described and approved in accordance with (f) below.
- (f) If shop drawings show variations from the contract requirements, the Contractor shall describe such variations in writing, separate from the drawings, at the time of submission. If the Architect approves any such variation and the Contracting Officer concurs, the Contracting Officer shall issue an appropriate modification to the contract, except that, if the variation is minor or does not involve a change in price or in time of performance, a modification need not be issued.
- (g) It shall be the responsibility of the Contractor to make timely requests of the PHA for such large scale and full size drawings, color schemes, and other additional information, not already in his possession, which shall be

required in the planning and production of the work. Such requests may be submitted as the need arises, but each such request shall be filed in ample time to permit appropriate action to be taken by all parties involved so as to avoid delay.

- (h) The Contractor shall submit to the Contracting Officer for approval four copies (unless otherwise indicated) of all shop drawings as called for under the various headings of these specifications. Three sets (unless otherwise indicated) of all shop drawings, will be retained by the PHA and one set will be returned to the Contractor. As required by the Contracting Officer, the Contractor, upon completing the work under this contract, shall furnish a complete set of all shop drawings as finally approved. These drawings shall show all changes and revisions made up to the time the work is completed and accepted.
- (i) This clause shall be included in all subcontracts at any tier. It shall be the responsibility of the Contractor to ensure that all shop drawings prepared by subcontractors are submitted to the Contracting Officer.

10. As-Built Drawings

- (a) "As-built drawings," as used in this clause, means drawings submitted by the Contractor or subcontractor at any tier to show the construction of a particular structure or work as actually completed under the contract. "As-built drawings" shall be synonymous with "Record drawings."
- (b) As required by the Contracting Officer, the Contractor shall provide the Contracting Officer accurate information to be used in the preparation of permanent as-built drawings. For this purpose, the Contractor shall record on one set of contract drawings all changes from the installations originally indicated, and record final locations of underground lines by depth from finish grade and by accurate horizontal offset distances to permanent surface improvements such as buildings, curbs, or edges of walks.
- (c) This clause shall be included in all subcontracts at any tier. It shall be the responsibility of the Contractor to ensure that all as-built drawings prepared by subcontractors are submitted to the Contracting Officer.

11. Material and Workmanship

- (a) All equipment, material, and articles furnished under this contract shall be new and of the most suitable grade for the purpose intended, unless otherwise specifically provided in this contract. References in the contract to equipment, material, articles, or patented processes by trade name, make, or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may, at its option, use any equipment, material, article, or process that, in the judgment of, and as approved by the Contracting Officer, is equal to that named in the specifications, unless otherwise specifically provided in this contract.
- (b) Approval of equipment and materials.
- (1) The Contractor shall obtain the Contracting Officer's approval of the machinery and mechanical and other equipment to be incorporated into the work. When requesting approval, the Contractor shall furnish to the Contracting Officer the name of the manufacturer, the model number, and other information concerning the performance, capacity, nature, and rating of the

machinery and mechanical and other equipment. When required by this contract or by the Contracting Officer, the Contractor shall also obtain the Contracting Officer's approval of the material or articles which the Contractor contemplates incorporating into the work. When requesting approval, the Contractor shall provide full information concerning the material or articles. Machinery, equipment, material, and articles that do not have the required approval shall be installed or used at the risk of subsequent rejection.

- (2) When required by the specifications or the Contracting Officer, the Contractor shall submit appropriately marked samples (and certificates related to them) for approval at the Contractor's expense, with all shipping charges prepaid. The Contractor shall label, or otherwise properly mark on the container, the material or product represented, its place of origin, the name of the producer, the Contractor's name, and the identification of the construction project for which the material or product is intended to be used.
- (3) Certificates shall be submitted in triplicate, describing each sample submitted for approval and certifying that the material, equipment or accessory complies with contract requirements. The certificates shall include the name and brand of the product, name of manufacturer, and the location where produced.
- (4) Approval of a sample shall not constitute a waiver of the PHA right to demand full compliance with contract requirements. Materials, equipment and accessories may be rejected for cause even though samples have been approved.
- (5) Wherever materials are required to comply with recognized standards or specifications, such specifications shall be accepted as establishing the technical qualities and testing methods, but shall not govern the number of tests required to be made nor modify other contract requirements. The Contracting Officer may require laboratory test reports on items submitted for approval or may approve materials on the basis of data submitted in certificates with samples. Check tests will be made on materials delivered for use only as frequently as the Contracting Officer determines necessary to insure compliance of materials with the specifications. The Contractor will assume all costs of retesting materials which fail to meet contract requirements and/or testing materials offered in substitution for those found deficient.
- (6) After approval, samples will be kept in the Project office until completion of work. They may be built into the work after a substantial quantity of the materials they represent has been built in and accepted.
- (c) Requirements concerning lead-based paint. The Contractor shall comply with the requirements concerning lead-based paint contained in the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. 4821-4846) as implemented by 24 CFR Part 35.

12. Permits and Codes

- (a) The Contractor shall give all notices and comply with all applicable laws, ordinances, codes, rules and regulations. Notwithstanding the requirement of the Contractor to comply with the drawings and specifications in the contract, all work installed shall comply with all applicable codes and regulations as amended by any

waivers. Before installing the work, the Contractor shall examine the drawings and the specifications for compliance with applicable codes and regulations bearing on the work and shall immediately report any discrepancy it may discover to the Contracting Officer.

Where the requirements of the drawings and specifications fail to comply with the applicable code or regulation, the Contracting Officer shall modify the contract by change order pursuant to the clause entitled Changes herein to conform to the code or regulation.

- (b) The Contractor shall secure and pay for all permits, fees, and licenses necessary for the proper execution and completion of the work. Where the PHA can arrange for the issuance of all or part of these permits, fees and licenses, without cost to the Contractor, the contract amount shall be reduced accordingly.

13. Health, Safety, and Accident Prevention

(a) In performing this contract, the Contractor shall:

- (1) Ensure that no laborer or mechanic shall be required to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his/her health and/or safety as determined under construction safety and health standards promulgated by the Secretary of Labor by regulation;
- (2) Protect the lives, health, and safety of other persons;
- (3) Prevent damage to property, materials, supplies, and equipment; and,
- (4) Avoid work interruptions.

(b) For these purposes, the Contractor shall:

- (1) Comply with regulations and standards issued by the Secretary of Labor at 29 CFR Part 1926. Failure to comply may result in imposition of sanctions pursuant to the Contract Work Hours and Safety Standards Act (Public Law 91-54, 83 Stat. 96), 40 U.S.C. 3701 et seq.; and
- (2) Include the terms of this clause in every subcontract so that such terms will be binding on each subcontractor.

(c) The Contractor shall maintain an accurate record of exposure data on all accidents incident to work performed under this contract resulting in death, traumatic injury, occupational disease, or damage to property, materials, supplies, or equipment, and shall report this data in the manner prescribed by 29 CFR Part 1904.

(d) The Contracting Officer shall notify the Contractor of any noncompliance with these requirements and of the corrective action required. This notice, when delivered to the Contractor or the Contractor's representative at the site of the work, shall be deemed sufficient notice of the noncompliance and corrective action required. After receiving the notice, the Contractor shall immediately take corrective action. If the Contractor fails or refuses to take corrective action promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. The Contractor shall not base any claim or request for equitable adjustment for additional time or money on any stop order issued under these circumstances.

(e) The Contractor shall be responsible for its subcontractors' compliance with the provisions of this clause. The Contractor shall take such action with respect to any subcontract as the PHA, the Secretary of Housing and Urban Development, or the Secretary of Labor shall direct as a means of enforcing such provisions.

14. Temporary Heating

The Contractor shall provide and pay for temporary heating, covering, and enclosures necessary to properly protect all work and materials against damage by dampness and cold, to dry out the work, and to facilitate the completion of the work. Any permanent heating equipment used shall be turned over to the PHA in the condition and at the time required by the specifications.

15. Availability and Use of Utility Services

(a) The PHA shall make all reasonably required amounts of utilities available to the Contractor from existing outlets and supplies, as specified in the contract. Unless otherwise provided in the contract, the amount of each utility service consumed shall be charged to or paid for by the Contractor at prevailing rates charged to the PHA or, where the utility is produced by the PHA, at reasonable rates determined by the Contracting Officer. The Contractor shall carefully conserve any utilities furnished without charge.

(b) The Contractor, at its expense and in a manner satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines, and all meters required to measure the amount of each utility used for the purpose of determining charges. Before final acceptance of the work by the PHA, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia.

16. Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements

(a) The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed under this contract, and which do not unreasonably interfere with the work required under this contract.

(b) The Contractor shall only remove trees when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during performance of this contract, or by the careless operation of equipment, or by workmen, the Contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree-pruning compound as directed by the Contracting Officer.

(c) The Contractor shall protect from damage all existing improvements and utilities (1) at or near the work site and (2) on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. Prior to disturbing the ground at the construction site, the Contractor shall ensure that all underground utility lines are clearly marked.

(d) The Contractor shall shore up, brace, underpin, secure, and protect as necessary all foundations and other parts of existing structures adjacent to, adjoining, and in the vicinity of the site, which may be affected by the excavations or other operations connected with the construction of the project.

(e) Any equipment temporarily removed as a result of work under this contract shall be protected, cleaned, and replaced in the same condition as at the time of award of this contract.

- (f) New work which connects to existing work shall correspond in all respects with that to which it connects and/or be similar to existing work unless otherwise required by the specifications.
- (g) No structural members shall be altered or in any way weakened without the written authorization of the Contracting Officer, unless such work is clearly specified in the plans or specifications.
- (h) If the removal of the existing work exposes discolored or unfinished surfaces, or work out of alignment, such surfaces shall be refinished, or the material replaced as necessary to make the continuous work uniform and harmonious. This, however, shall not be construed to require the refinishing or reconstruction of dissimilar finishes previously exposed, or finished surfaces in good condition, but in different planes or on different levels **Construction** when brought together by the removal of intervening work, unless such refinishing or reconstruction is specified in the plans or specifications.
- (i) The Contractor shall give all required notices to any adjoining or adjacent property owner or other party before the commencement of any work.
- (j) The Contractor shall indemnify and save harmless the PHA from any damages on account of settlement or the loss of lateral support of adjoining property, any damages from changes in topography affecting drainage, and from all loss or expense and all damages for which the PHA may become liable in consequence of such injury or damage to adjoining and adjacent structures and their premises.
- (k) The Contractor shall repair any damage to vegetation, structures, equipment, utilities, or improvements, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

17. Temporary Buildings and Transportation of Materials

- (a) Temporary buildings (e.g., storage sheds, shops, offices, sanitary facilities) and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the PHA. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.
- (b) The Contractor shall, as directed by the Contracting Officer, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer. When materials are transported in prosecuting the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any federal, state, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.

18. Clean Air and Water

The contractor shall comply with the Clean Air Act, as amended, 42 USC 7401 et seq., the Federal Water Pollution Control Water Act, as amended, 33 U.S.C. 1251 et seq., and standards issued pursuant thereto in the facilities in which this contract is to be performed.

19. Energy Efficiency

The Contractor shall comply with mandatory standards and policies relating to energy efficiency which are contained in the energy conservation plan issued in compliance with the Energy Policy and Conservation Act (Pub.L. 94-163) for the State in which the work under the contract is performed.

20. Inspection and Acceptance of

- (a) Definitions. As used in this clause -
- (1) "Acceptance" means the act of an authorized representative of the PHA by which the PHA approves and assumes ownership of the work performed under this contract. Acceptance may be partial or complete.
- (2) "Inspection" means examining and testing the work performed under the contract (including, when appropriate, raw materials, equipment, components, and intermediate assemblies) to determine whether it conforms to contract requirements.
- (3) "Testing" means that element of inspection that determines the properties or elements, including functional operation of materials, equipment, or their components, by the application of established scientific principles and procedures.
- (b) The Contractor shall maintain an adequate inspection system and perform such inspections as will ensure that the work performed under the contract conforms to contract requirements. All work is subject to PHA inspection and test at all places and at all reasonable times before acceptance to ensure strict compliance with the terms of the contract.
- (c) PHA inspections and tests are for the sole benefit of the PHA and do not: (1) relieve the Contractor of responsibility for providing adequate quality control measures; (2) relieve the Contractor of responsibility for loss or damage of the material before acceptance; (3) constitute or imply acceptance; or, (4) affect the continuing rights of the PHA after acceptance of the completed work under paragraph (j) below.
- (d) The presence or absence of the PHA inspector does not relieve the Contractor from any contract requirement, nor is the inspector authorized to change any term or condition of the specifications without the Contracting Officer's written authorization. All instructions and approvals with respect to the work shall be given to the Contractor by the Contracting Officer.
- (e) The Contractor shall promptly furnish, without additional charge, all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by the Contracting Officer. The PHA may charge to the Contractor any additional cost of inspection or test when work is not ready at the time specified by the Contractor for inspection or test, or when prior rejection makes reinspection or retest necessary. The PHA shall perform all inspections and tests in a manner that will not unnecessarily delay the work. Special, full size, and performance tests shall be performed as described in the contract.

- (f) The PHA may conduct routine inspections of the construction site on a daily basis.
- (g) The Contractor shall, without charge, replace or correct work found by the PHA not to conform to contract requirements, unless the PHA decides that it is in its interest to accept the work with an appropriate adjustment in contract price. The Contractor shall promptly segregate and remove rejected material from the premises.
- (h) If the Contractor does not promptly replace or correct rejected work, the PHA may (1) by contract or otherwise, replace or correct the work and charge the cost to the Contractor, or (2) terminate for default the Contractor's right to proceed.
- (i) If any work requiring inspection is covered up without approval of the PHA, it must, if requested by the Contracting Officer, be uncovered at the expense of the Contractor. If at any time before final acceptance of the entire work, the **Construction PHA** considers it necessary or advisable, to examine work already completed by removing or tearing it out, the Contractor, shall on request, promptly furnish all necessary facilities, labor, and material. If such work is found to be defective or nonconforming in any material respect due to the fault of the Contractor or its subcontractors, the Contractor shall defray all the expenses of the examination and of satisfactory reconstruction. If, however, such work is found to meet the requirements of the contract, the Contracting Officer shall make an equitable adjustment to cover the cost of the examination and reconstruction, including, if completion of the work was thereby delayed, an extension of time.
- (j) The Contractor shall notify the Contracting Officer, in writing, as to the date when in its opinion all or a designated portion of the work will be substantially completed and ready for inspection. If the Architect determines that the state of preparedness is as represented, the PHA will promptly arrange for the inspection. Unless otherwise specified in the contract, the PHA shall accept, as soon as practicable after completion and inspection, all work required by the contract or that portion of the work the Contracting Officer determines and designates can be accepted separately. Acceptance shall be final and conclusive except for latent defects, fraud, gross mistakes amounting to fraud, or the PHA's right under any warranty or guarantee.

21. Use and Possession Prior to Completion

- (a) The PHA shall have the right to take possession of or use any completed or partially completed part of the work. Before taking possession of or using any work, the Contracting Officer shall furnish the Contractor a list of items of work remaining to be performed or corrected on those portions of the work that the PHA intends to take possession of or use. However, failure of the Contracting Officer to list any item of work shall not relieve the Contractor of responsibility for complying with the terms of the contract. The PHA's possession or use shall not be deemed an acceptance of any work under the contract.
- (b) While the PHA has such possession or use, the Contractor shall be relieved of the responsibility for (1) the loss of or damage to the work resulting from the PHA's possession or use, notwithstanding the terms of the clause entitled Permits and Codes herein; (2) all maintenance costs on the areas occupied; and, (3) furnishing heat, light, power, and water used in the areas

occupied without proper remuneration therefore. If prior possession or use by the PHA delays the progress of the work or causes additional expense to the Contractor, an equitable adjustment shall be made in the contract price or the time of completion, and the contract shall be modified in writing accordingly.

22. Warranty of Title

The Contractor warrants good title to all materials, supplies, and equipment incorporated in the work and agrees to deliver the premises together with all improvements thereon free from any claims, liens or charges, and agrees further that neither it nor any other person, firm or corporation shall have any right to a lien upon the premises or anything appurtenant thereto.

23. Warranty of

- (a) In addition to any other warranties in this contract, the Contractor warrants, except as provided in paragraph (j) of this clause, that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, or workmanship performed by the Contractor or any subcontractor or supplier at any tier. This warranty shall continue for a period of _____ (one year unless otherwise indicated) from the date of final acceptance of the work. If the PHA takes possession of any part of the work before final acceptance, this warranty shall continue for a period of (one year unless otherwise indicated) from the date that the PHA takes possession.
- (b) The Contractor shall remedy, at the Contractor's expense, any failure to conform, or any defect. In addition, the Contractor shall remedy, at the Contractor's expense, any damage to PHA-owned or controlled real or personal property when the damage is the result of—
 - (1) The Contractor's failure to conform to contract requirements; or
 - (2) Any defects of equipment, material, workmanship or design furnished by the Contractor.
- (c) The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced will run for (one year unless otherwise indicated) from the date of repair or replacement.
- (d) The Contracting Officer shall notify the Contractor, in writing, within a reasonable time after the discovery of any failure, defect or damage.
- (e) If the Contractor fails to remedy any failure, defect, or damage within a reasonable time after receipt of notice, the PHA shall have the right to replace, repair or otherwise remedy the failure, defect, or damage at the Contractor's expense.
- (f) With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall:
 - (1) Obtain all warranties that would be given in normal commercial practice;
 - (2) Require all warranties to be executed in writing, for the benefit of the PHA; and,
 - (3) Enforce all warranties for the benefit of the PHA.
- (g) In the event the Contractor's warranty under paragraph (a) of this clause has expired, the PHA may bring suit at its own expense to enforce a subcontractor's, manufacturer's or supplier's warranty.

- (h) Unless a defect is caused by the negligence of the Contractor or subcontractor or supplier at any tier, the Contractor shall not be liable for the repair of any defect of material or design furnished by the PHA nor for the repair of any damage that results from any defect in PHA furnished material or design.
- (i) Notwithstanding any provisions herein to the contrary, the establishment of the time periods in paragraphs (a) and (c) above relate only to the specific obligation of the Contractor to correct the work, and have no relationship to the time within which its obligation to comply with the contract may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to its obligation other than specifically to correct the work.
- (j) This warranty shall not limit the PHA's rights under the Inspection and Acceptance of Construction clause of this contract with respect to latent defects, gross mistakes or fraud.

24. Prohibition Against Liens

The Contractor is prohibited from placing a lien on the PHA's property. This prohibition shall apply to all subcontractors at any tier and all materials suppliers.

Administrative Requirements

25. Contract Period

this contract within _____ calendar days of the effective date of the contract, or within the time schedule established in the notice to proceed issued by the Contracting Officer.

26. Order of Provisions

accordance with the terms and conditions of the

In the event of a conflict between these General Conditions and the Specifications, the General Conditions shall prevail. In the event of a conflict between the contract and any applicable state or local law or regulation, the state or local law or regulation shall prevail; provided that such state or local law or regulation does not conflict with, or is less restrictive than applicable federal law, regulation, or Executive Order. In the event of such a conflict, applicable federal law, regulation, and Executive Order shall prevail.

27. Payments

retain ten (10) percent of the amount of progress

- (a) The PHA shall pay the Contractor the price as provided in this contract.
- (b) The PHA shall make progress payments approximately every 30 days as the work proceeds, on estimates of work accomplished which meets the standards of quality established under the contract, as approved by the Contracting Officer. The PHA may, subject to written determination and approval of the Contracting Officer, make more frequent payments to contractors which are qualified small businesses.
- (c) Before the first progress payment under this contract, the Contractor shall furnish, in such detail as requested by the Contracting Officer, a breakdown of the total contract price showing the amount included therein for each principal category of the work, which shall substantiate the payment amount requested in order to provide a

basis for determining progress payments. The breakdown shall be approved by the Contracting Officer and must be acceptable to HUD. If the contract covers more than one project, the Contractor shall furnish a separate breakdown for each. The values and quantities employed in making up this breakdown are for determining the amount of progress payments and shall not be construed as a basis for additions to or deductions from the contract price. The Contractor shall prorate its overhead and profit over the construction period of the contract.

- (d) The Contractor shall submit, on forms provided by the PHA, periodic estimates showing the value of the work performed during each period based upon the approved

submitted not later than _____ days in advance of the date set for payment and are subject to correction and revision as required. The estimates must be approved by the Contracting Officer with the concurrence of the Architect prior to payment. If the contract covers more than one project, the Contractor shall furnish a separate progress payment estimate for each.

- (e) Along with each request for progress payments and the required estimates, the Contractor shall furnish the following certification, or payment shall not be made: I hereby certify, to the best of my knowledge and belief, that:

- (1) The amounts requested are only for performance in accordance with the specifications, terms, and conditions of the contract;
- (2) Payments to subcontractors and suppliers have been made from previous payments received under the contract, and timely payments will be made from the proceeds of the payment covered by this certification, in accordance with subcontract agreements; and,
- (3) This request for progress payments does not include any amounts which the prime contractor intends to withhold or retain from a subcontractor or supplier in subcontract.

Name:

Title:

Date:

- (f) Except as otherwise provided in State law, the PHA shall

payments until completion and acceptance of all work under the contract; except, that if upon completion of 50 percent of the work, the Contracting Officer, after consulting with the Architect, determines that the Contractor's performance and progress are satisfactory, the PHA may make the remaining payments in full for the work subsequently completed. If the Contracting Officer subsequently determines that the Contractor's performance and progress are unsatisfactory, the PHA shall reinstate the ten (10) percent (or other percentage as provided in State law) retainage until such time as the Contracting Officer determines that performance and progress are satisfactory.

- (g) The Contracting Officer may authorize material delivered on the site and preparatory work done to be taken into consideration when computing progress payments.

Material delivered to the Contractor at locations other than the site may also be taken into consideration if the Contractor furnishes satisfactory evidence that (1) it has acquired title to such material; (2) the material is properly stored in a bonded warehouse, storage yard, or similar suitable place as may be approved by the Contracting Officer; (3) the material is insured to cover its full value; and (4) the material will be used to perform this contract. Before any progress payment which includes delivered material is made, the Contractor shall furnish such documentation as the Contracting Officer may require to assure the protection of the PHA's interest in such materials. The Contractor shall remain responsible for such stored material notwithstanding the transfer of title to the PHA.

- (h) All material and work covered by progress payments made shall, at the time of payment become the sole property of the PHA, but this shall not be construed as (1) relieving the Contractor from the sole responsibility for all material and work upon which payments have been made or the restoration of any damaged work; or, (2) waiving the right of the PHA to require the fulfillment of all of the terms of the contract. In the event the work of the Contractor has been damaged by other contractors or persons other than employees of the PHA in the course of their employment, the Contractor shall restore such damaged work without cost to the PHA and to seek redress for its damage only from those who directly caused it.
- (i) The PHA shall make the final payment due the Contractor under this contract after (1) completion and final acceptance of all work; and (2) presentation of release of all claims against the PHA arising by virtue of this contract, other than claims, in stated amounts, that the Contractor has specifically excepted from the operation of the release. Each such exception shall embrace no more than one claim, the basis and scope of which shall be clearly defined. The amounts for such excepted claims shall not be included in the request for final payment. A release may also be required of the assignee if the Contractor's claim to amounts payable under this contract has been assigned.
- (j) Prior to making any payment, the Contracting Officer may require the Contractor to furnish receipts or other evidence of payment from all persons performing work and supplying material to the Contractor, if the Contracting Officer determines such evidence is necessary to substantiate claimed costs.
- (k) The PHA shall not; (1) determine or adjust any claims for payment or disputes arising there under between the Contractor and its subcontractors or material suppliers; or, (2) withhold any moneys for the protection of the subcontractors or material suppliers. The failure or refusal of the PHA to withhold moneys from the Contractor shall in nowise impair the obligations of any surety or sureties under any bonds furnished under this contract.

28. Contract Modifications

- (a) Only the Contracting Officer has authority to modify any term or condition of this contract. Any contract modification shall be authorized in writing.
- (b) The Contracting Officer may modify the contract unilaterally (1) pursuant to a specific authorization stated in a contract clause (e.g., Changes); or (2) for administrative matters which do not change the rights or

responsibilities of the parties (e.g., change in the PHA address). All other contract modifications shall be in the form of supplemental agreements signed by the Contractor and the Contracting Officer.

- (c) When a proposed modification requires the approval of HUD prior to its issuance (e.g., a change order that exceeds the PHA's approved threshold), such modification shall not be effective until the required approval is received by the PHA.

29. Changes

- (a) The Contracting Officer may, at any time, without notice to the sureties, by written order designated or indicated to be a change order, make changes in the work within the general scope of the contract including changes:
 - (1) In the specifications (including drawings and designs);
 - (2) In the method or manner of performance of the work;
 - (3) PHA-furnished facilities, equipment, materials, services, or site; or,
 - (4) Directing the acceleration in the performance of the work.
- (b) Any other written order or oral order (which, as used in this paragraph (b), includes direction, instruction, interpretation, or determination) from the Contracting Officer that causes a change shall be treated as a change order under this clause; provided, that the Contractor gives the Contracting Officer written notice stating (1) the date, circumstances and source of the order and (2) that the Contractor regards the order as a change order.
- (c) Except as provided in this clause, no order, statement or conduct of the Contracting Officer shall be treated as a change under this clause or entitle the Contractor to an equitable adjustment.
- (d) If any change under this clause causes an increase or decrease in the Contractor's cost of, or the time required for the performance of any part of the work under this contract, whether or not changed by any such order, the Contracting Officer shall make an equitable adjustment and modify the contract in writing. However, except for an adjustment based on defective specifications, no proposal for any change under paragraph (b) above shall be allowed for any costs incurred more than 20 days (5 days for oral orders) before the Contractor gives written notice as required. In the case of defective specifications for which the PHA is responsible, the equitable adjustment shall include any increased cost reasonably incurred by the Contractor in attempting to comply with the defective specifications.
- (e) The Contractor must assert its right to an adjustment under this clause within 30 days after (1) receipt of a written change order under paragraph (a) of this clause, or (2) the furnishing of a written notice under paragraph (b) of this clause, by submitting a written statement describing the general nature and the amount of the proposal. If the facts justify it, the Contracting Officer may extend the period for submission. The proposal may be included in the notice required under paragraph (b) above. No proposal by the Contractor for an equitable adjustment shall be allowed if asserted after final payment under this contract.
- (f) The Contractor's written proposal for equitable adjustment shall be submitted in the form of a lump sum proposal supported with an itemized breakdown of all increases and decreases in the contract in at least the following details:

- (1) Direct Costs. Materials (list individual items, the quantity and unit cost of each, and the aggregate cost); Transportation and delivery costs associated with materials; Labor breakdowns by hours or unit costs (identified with specific work to be performed); Construction equipment exclusively necessary for the change; Costs of preparation and/ or revision to shop drawings resulting from the change; Worker's Compensation and Public Liability Insurance; Employment taxes under FICA and FUTA; and, Bond Costs when size of change warrants revision.
- (2) Indirect Costs. Indirect costs may include overhead, general and administrative expenses, and fringe benefits not normally treated as direct costs.
- (3) Profit. The amount of profit shall be negotiated and may vary according to the nature, extent, and complexity of the work required by the change. The allowability of the direct and indirect costs shall be determined in accordance with the Contract Cost Principles and Procedures for Commercial Firms in Part 31 of the Federal Acquisition Regulation (48 CFR 1-31), as implemented by HUD Handbook 2210.18, in effect on the date of this contract. The Contractor shall not be allowed a profit on the profit received by any subcontractor. Equitable adjustments for deleted work shall include a credit for profit and may include a credit for indirect costs. On proposals covering both increases and decreases in the amount of the contract, the application of indirect costs and profit shall be on the net-change in direct costs for the Contractor or subcontractor performing the work.
- (g) The Contractor shall include in the proposal its request for time extension (if any), and shall include sufficient information and dates to demonstrate whether and to what extent the change will delay the completion of the contract in its entirety.
- (h) The Contracting Officer shall act on proposals within 30 days after their receipt, or notify the Contractor of the date when such action will be taken.
- (i) Failure to reach an agreement on any proposal shall be a dispute under the clause entitled Disputes herein. Nothing in this clause, however, shall excuse the Contractor from proceeding with the contract as changed.
- (j) Except in an emergency endangering life or property, no change shall be made by the Contractor without a prior order from the Contracting Officer.

30. Suspension of Work

- (a) The Contracting Officer may order the Contractor in writing to suspend, delay, or interrupt all or any part of the work of this contract for the period of time that the Contracting Officer determines appropriate for the convenience of the PHA.
- (b) If the performance of all or any part of the work is, for an unreasonable period of time, suspended, delayed, or interrupted (1) by an act of the Contracting Officer in the administration of this contract, or (2) by the Contracting Officer's failure to act within the time specified (or within a reasonable time if not specified) in this contract an adjustment shall be made for any increase in the cost of performance of the contract (excluding profit) necessarily caused by such unreasonable suspension, delay, or interruption and the contract modified in writing accordingly. However, no adjustment shall be made under this clause for any suspension, delay, or interruption to the extent that performance would have

- been so suspended, delayed, or interrupted by any other cause, including the fault or negligence of the Contractor or for which any equitable adjustment is provided for or excluded under any other provision of this contract.
- (c) A claim under this clause shall not be allowed (1) for any costs incurred more than 20 days before the Contractor shall have notified the Contracting Officer in writing of the act or failure to act involved (but this requirement shall not apply as to a claim resulting from a suspension order); and, (2) unless the claim, in an amount stated, is asserted in writing as soon as practicable after the termination of the suspension, delay, or interruption, but not later than the date of final payment under the contract.

31. Disputes

- (a) "Claim," as used in this clause, means a written demand or written assertion by one of the contracting parties seeking, as a matter of right, the payment of money in a sum certain, the adjustment or interpretation of contract terms, or other relief arising under or relating to the contract. A claim arising under the contract, unlike a claim relating to the contract, is a claim that can be resolved under a contract clause that provides for the relief sought by the claimant. A voucher, invoice, or other routine request for payment that is not in dispute when submitted is not a claim. The submission may be converted to a claim by complying with the requirements of this clause, if it is disputed either as to liability or amount or is not acted upon in a reasonable time.
- (b) Except for disputes arising under the clauses entitled Labor Standards - Davis Bacon and Related Acts, herein, all disputes arising under or relating to this contract, including any claims for damages for the alleged breach thereof which are not disposed of by agreement, shall be resolved under this clause.
- (c) All claims by the Contractor shall be made in writing and submitted to the Contracting Officer for a written decision. A claim by the PHA against the Contractor shall be subject to a written decision by the Contracting Officer.
- (d) The Contracting Officer shall, within 60 (unless otherwise indicated) days after receipt of the request, decide the claim or notify the Contractor of the date by which the decision will be made.
- (e) The Contracting Officer's decision shall be final unless the Contractor (1) appeals in writing to a higher level in the PHA in accordance with the PHA's policy and procedures, (2) refers the appeal to an independent mediator or arbitrator, or (3) files suit in a court of competent jurisdiction. Such appeal must be made within (30 unless otherwise indicated) days after receipt of the Contracting Officer's decision.
- (f) The Contractor shall proceed diligently with performance of this contract, pending final resolution of any request for relief, claim, appeal, or action arising under or relating to the contract, and comply with any decision of the Contracting Officer.

32. Default

- (a) If the Contractor refuses or fails to prosecute the work, or any separable part thereof, with the diligence that will insure its completion within the time specified in this contract, or any extension thereof, or fails to complete said work within this time, the Contracting Officer may, by written notice to the Contractor, terminate the right to

proceed with the work (or separable part of the work) that has been delayed. In this event, the PHA may take over the work and complete it, by contract or otherwise, and may take possession of and use any materials, equipment, and plant on the work site necessary for completing the work. The Contractor and its sureties shall be liable for any damage to the PHA resulting from the **Convenience** Contractor's refusal or failure to complete the work within the specified time, whether or not the Contractor's right to proceed with the work is terminated. This liability includes any increased costs incurred by the PHA in completing the work.

- (b) The Contractor's right to proceed shall not be terminated or the Contractor charged with damages under this clause if—
- (1) The delay in completing the work arises from unforeseeable causes beyond the control and without the fault or negligence of the Contractor. Examples of such causes include (i) acts of God, or of the public enemy, (ii) acts of the PHA or other governmental entity in either its sovereign or contractual capacity, (iii) acts of another contractor in the performance of a contract with the PHA, (iv) fires, (v) floods, (vi) epidemics, (vii) quarantine restrictions, (viii) strikes, (ix) freight embargoes, (x) unusually severe weather, or (xi) delays of subcontractors or suppliers at any tier arising from unforeseeable causes beyond the control and without the fault or negligence of both the Contractor and the subcontractors or suppliers; and
- (2) The Contractor, within days (10 days unless otherwise indicated) from the beginning of such delay (unless extended by the Contracting Officer) notifies the Contracting Officer in writing of the causes of delay. The Contracting Officer shall ascertain the facts and the extent of the delay. If, in the judgment of the Contracting Officer, the findings of fact warrant such action, time for completing the work shall be extended by written modification to the contract. The findings of the Contracting Officer shall be reduced to a written decision which shall be subject to the provisions of the Disputes clause of this contract.
- (c) If, after termination of the Contractor's right to proceed, it is determined that the Contractor was not in default, or that the delay was excusable, the rights and obligations of the parties will be the same as if the termination had been for convenience of the PHA.

33. Liquidated Damages

- (a) If the Contractor fails to complete the work within the time specified in the contract, or any extension, as specified in the clause entitled Default of this contract, the Contractor shall pay to the PHA as liquidated damages, the sum of \$ _____ [Contracting Officer insert amount] for each day of delay. If different completion dates are specified in the contract for separate parts or stages of the work, the amount of liquidated damages shall be assessed on those parts or stages which are delayed. To the extent that the Contractor's delay or nonperformance is excused under another clause in this contract, liquidated damages shall not be due the PHA. The Contractor remains liable for damages caused other than by delay.
- (b) If the PHA terminates the Contractor's right to proceed, the resulting damage will consist of liquidated damages until such reasonable time as may be required for final

completion of the work together with any increased costs occasioned the PHA in completing the work.

- (c) If the PHA does not terminate the Contractor's right to proceed, the resulting damage will consist of liquidated damages until the work is completed or accepted.

34. Termination for

- (a) The Contracting Officer may terminate this contract in whole, or in part, whenever the Contracting Officer determines that such termination is in the best interest of the PHA. Any such termination shall be effected by delivery to the Contractor of a Notice of Termination specifying the extent to which the performance of the work under the contract is terminated, and the date upon which such termination becomes effective.
- (b) If the performance of the work is terminated, either in whole or in part, the PHA shall be liable to the Contractor for reasonable and proper costs resulting from such termination upon the receipt by the PHA of a properly presented claim setting out in detail: (1) the total cost of the work performed to date of termination less the total amount of contract payments made to the Contractor; (2) the cost (including reasonable profit) of settling and paying claims under subcontracts and material orders for work performed and materials and supplies delivered to the site, payment for which has not been made by the PHA to the Contractor or by the Contractor to the subcontractor or supplier; (3) the cost of preserving and protecting the work already performed until the PHA or assignee takes possession thereof or assumes responsibility therefore; (4) the actual or estimated cost of legal and accounting services reasonably necessary to prepare and present the termination claim to the PHA; and (5) an amount constituting a reasonable profit on the value of the work performed by the Contractor.
- (c) The Contracting Officer will act on the Contractor's claim within days (60 days unless otherwise indicated) of receipt of the Contractor's claim.
- (d) Any disputes with regard to this clause are expressly made subject to the provisions of the Disputes clause of this contract.

35. Assignment of Contract

The Contractor shall not assign or transfer any interest in this contract; except that claims for monies due or to become due from the PHA under the contract may be assigned to a bank, trust company, or other financial institution. Such assignments of claims shall only be made with the written concurrence of the Contracting Officer. If the Contractor is a partnership, this contract shall inure to the benefit of the surviving or remaining member(s) of such partnership as approved by the Contracting Officer.

36. Insurance

- (a) Before commencing work, the Contractor and each subcontractor shall furnish the PHA with certificates of insurance showing the following insurance is in force and will insure all operations under the Contract:
- (1) Workers' Compensation, in accordance with state or Territorial Workers' Compensation laws.
- (2) Commercial General Liability with a combined single limit for bodily injury and property damage of not less than \$ _____ [Contracting Officer insert amount]

per occurrence to protect the Contractor and each subcontractor against claims for bodily injury or death and damage to the property of others. This shall cover the use of all equipment, hoists, and vehicles on the site(s) not covered by Automobile Liability under (3) below. If the Contractor has a "claims made" policy, then the following additional requirements apply: the policy must provide a "retroactive date" which must be on or before the execution date of the Contract; and the extended reporting period may not be less than five years following the completion date of the Contract.

(3) Automobile Liability on owned and non-owned motor vehicles used on the site(s) or in connection therewith for a combined single limit for bodily injury and property damage of not less than \$ _____

[Contracting Officer insert amount] per occurrence.

(b) Before commencing work, the Contractor shall furnish the PHA with a certificate of insurance evidencing that Builder's Risk (fire and extended coverage) Insurance on all work in place and/or materials stored at the building site(s), including foundations and building equipment, is in force. The Builder's Risk Insurance shall be for the benefit of the Contractor and the PHA as their interests may appear and each shall be named in the policy or policies as an insured. The Contractor in installing equipment supplied by the PHA shall carry insurance on such equipment from the time the Contractor takes possession thereof until the Contract work is accepted by the PHA. The Builder's Risk Insurance need not be carried on excavations, piers, footings, or foundations until such time as work on the superstructure is started. It need not be carried on landscape work. Policies shall furnish coverage at all times for the full cash value of all completed construction, as well as materials in place and/or stored at the site(s), whether or not partial payment has been made by the PHA. The Contractor may terminate this insurance on buildings as of the date taken over for occupancy by the PHA. The Contractor is not required to carry Builder's Risk Insurance for modernization work which does not involve structural alterations or additions and where the PHA's existing fire and extended coverage policy can be endorsed to include such work.

(c) All insurance shall be carried with companies which are financially responsible and admitted to do business in the State in which the project is located. If any such insurance is due to expire during the construction period, the Contractor (including subcontractors, as applicable) shall not permit the coverage to lapse and shall furnish evidence of coverage to the Contracting Officer. All certificates of insurance, as evidence of coverage, shall provide that no coverage may be canceled or non-renewed by the insurance company until at least 30 days prior written notice has been given to the Contracting Officer.

37. Subcontracts

(a) Definitions. As used in this contract -

(1) "Subcontract" means any contract, purchase order, or other purchase agreement, including modifications and change orders to the foregoing, entered into by a subcontractor to furnish supplies, materials, equipment, and services for the performance of the prime contract or a subcontract.

(2) "Subcontractor" means any supplier, vendor, or firm that furnishes supplies, materials, equipment, or services to or for the Contractor or another subcontractor.

(b) The Contractor shall not enter into any subcontract with any subcontractor who has been temporarily denied participation in a HUD program or who has been suspended or debarred from participating in contracting programs by any agency of the United States Government or of the state in which the work under this contract is to be performed.

(c) The Contractor shall be as fully responsible for the acts or omissions of its subcontractors, and of persons either directly or indirectly employed by them as for the acts or omissions of persons directly employed by the Contractor.

(d) The Contractor shall insert appropriate clauses in all subcontracts to bind subcontractors to the terms and conditions of this contract insofar as they are applicable to the work of subcontractors.

(e) Nothing contained in this contract shall create any contractual relationship between any subcontractor and the PHA or between the subcontractor and HUD.

38. Subcontracting with Small and Minority Firms, Women's Business Enterprise, and Labor Surplus Area Firms

The Contractor shall take the following steps to ensure that, whenever possible, subcontracts are awarded to small business firms, minority firms, women's business enterprises, and labor surplus area firms:

- (a) Placing qualified small and minority businesses and women's business enterprises on solicitation lists;
- (b) Ensuring that small and minority businesses and women's business enterprises are solicited whenever they are potential sources;
- (c) Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority businesses and women's business enterprises;
- (d) Establishing delivery schedules, where the requirements of the contract permit, which encourage participation by small and minority businesses and women's business enterprises; and
- (e) Using the services and assistance of the U.S. Small Business Administration, the Minority Business Development Agency of the U.S. Department of Commerce, and State and local governmental small business agencies.

39. Equal Employment Opportunity

During the performance of this contract, the Contractor/Seller agrees as follows:

(a) The Contractor/Seller shall not discriminate against any employee or applicant for employment because of race color, religion, sex, sexual orientation, gender identity, disability, or national origin.

(b) The Contractor/Seller shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, sexual orientation, gender identity, disability, or national origin. Such action shall include, but not be limited to, (1) employment, (2) upgrading demotion, (4) transfer, (5) recruitment or recruitment advertising, (6) layoff or termination, (7) rates of pay or other forms of compensation, and (8) selection for training, including apprenticeship

(c) The Contractor/Seller agrees to post in conspicuous places available to employees and applicants for employment the notices to be provided by the Contracting Officer setting forth the provisions of this nondiscrimination clause.

(d) The Contractor/Seller shall, in all solicitations or advertisements for employees placed by or on behalf of the Contractor/Seller, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(e) The Contractor/Seller shall send, to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, the notice to be provided by the Contracting Officer advising the labor union or workers' representative of the Contractor's commitments under this clause, and post copies of the notice in conspicuous places available to employees and applicants for employment.

(f) The Contractor/Seller shall comply with Executive Order 11246, as amended, and the rules, regulations, and orders of the Secretary of Labor.

(g) The Contractor/Seller shall furnish all information and reports required by Executive Order 11246, as amended, Section 503 of the Rehabilitation Act of 1973, as amended, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto. The Contractor/Seller shall permit

access to its books, records, and accounts by the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(h) In the event of a that the Contractor/Seller is in noncompliance with the nondiscrimination clauses of this contract or with any of such rules, regulations, or orders, this contract may be canceled, terminated or suspended in whole or in part and the contractor/seller may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(i) The contractor/seller will include the provisions of paragraphs (a) through (h) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each sub[contractor/seller] or vendor. The [contractor/seller] will take such action with respect to any subcontract or purchase order as may be directed by the Secretary of Labor as a means of enforcing such provisions including sanctions for noncompliance: Provided, however, that in the event the [contractor/seller] becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction, the [contractor/seller] may request the United States to enter into such litigation to protect the interests of the United States.

(j) Compliance with the requirements of this clause shall be to the maximum extent consistent with, but not in derogation of, compliance with section 7(b) of the Indian Self-Determination and Education Assistance Act and the Indian Preference clause of this contract.

40. Employment, Training, and Contracting Opportunities for Low-Income Persons, Section 3 of the Housing and Urban Development Act of 1968.

(a) The work to be performed under this contract is subject to the requirements of Section 3 of the Housing and Urban Development Act of 1968, as amended, 12 U.S.C. 1701u (section 3). The purpose of section 3 is to ensure that employment and other economic opportunities generated by HUD assistance or HUD-assisted projects covered by Section 3, shall, to the greatest extent feasible, be directed to low- and very low-income persons, particularly persons who are recipients of HUD assistance for housing.

(b) The parties to this contract agree to comply with HUD's regulations in 24 CFR Part 75, which implement Section 3. As evidenced by their execution of this contract, the parties to this contract certify that they are under no contractual or other impediment that would prevent them from complying with the Part 75 regulations.

(c) The contractor agrees to send to each labor organization or representative of workers with which the contractor has a collective bargaining agreement or other understanding, if any, a notice advising the labor organization or workers' representative of the contractor's commitments under this section 3 clause and will post copies of the notice in conspicuous places at the work site where both employees and applicants for training and employment positions can see the notice. The notice shall describe the Section 3 prioritization requirements and shall state the minimum percentages of labor hour requirements established in the Benchmark Notice (FR-6085-N-04).

(d) The contractor agrees to include this section 3 clause in every subcontract subject to compliance with regulations in 24 CFR Part 75, and agrees to take appropriate action, as provided in an applicable provision of the subcontract or in this section 3 clause, upon a finding that the subcontractor is in violation of the regulations in 24 CFR Part 75. The contractor will not subcontract with any subcontractor where the contractor has notice or knowledge that the subcontractor has been found in violation of the regulations in 24 CFR Part 75.

(e) Noncompliance with HUD's regulations in 24 CFR Part 75 may result in sanctions, termination of this contract for default, and debarment or suspension from future HUD assisted contracts.

(f) Contracts, subcontracts, grants, or subgrants subject to Section 7(b) of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 5307(b)) or subject to tribal preference requirements as authorized under 101(k) of the Native American Housing Assistance and Self-Determination Act (25 U.S.C. 4111(k)) must provide preferences in employment, training, and business opportunities to Indians and Indian organizations, and are therefore not subject to the requirements of 24 CFR Part 75.

41. Interest of Members of Congress

No member of or delegate to the Congress of the United States of America shall be admitted to any share or part of this contract or to any benefit that may arise therefrom.

42. Interest of Members, Officers, or Employees and Former Members, Officers, or Employees

No member, officer, or employee of the PHA, no member of the governing body of the locality in which the project is situated, no member of the governing body of the locality in which the PHA was activated, and no other public official of such locality or localities who exercises any functions or responsibilities with respect to the project, shall, during his or her tenure, or for one year thereafter, have any interest, direct or indirect, in this contract or the proceeds thereof.

43. Limitations on Payments made to Influence Certain Federal Financial Transactions

- (a) The Contractor agrees to comply with Section 1352 of Title 31, United States Code which prohibits the use of **Acts** Federal appropriated funds to pay any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, and officer or employee of Congress, or an employee of a Member of Congress in connection with any of the following covered Federal actions: the awarding of any Federal contract; the making of any Federal grant; the making of any Federal loan; the entering into of any cooperative agreement; or the modification of any Federal contract, grant, loan, or cooperative agreement.
- (b) The Contractor further agrees to comply with the requirement of the Act to furnish a disclosure (OMB Standard Form LLL, Disclosure of Lobbying Activities) if any funds other than Federal appropriated funds (including profit or fee received under a covered Federal transaction) have been paid, or will be paid, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with a Federal contract, grant, loan, or cooperative agreement.

44. Royalties and Patents

The Contractor shall pay all royalties and license fees. It shall defend all suits or claims for infringement of any patent rights and shall save the PHA harmless from loss on account thereof; except that the PHA shall be responsible for all such loss when a particular design, process or the product of a particular manufacturer or manufacturers is specified and the Contractor has no reason to believe that the specified design, process, or product is an infringement. If, however, the Contractor has reason to believe that any design, process or product specified is an infringement of a patent, the Contractor shall promptly notify the Contracting Officer. Failure to give such notice shall make the Contractor responsible for resultant loss.

45. Examination and Retention of Contractor's Records

- (a) The PHA, HUD, or Comptroller General of the United States, or any of their duly authorized representatives shall, until 3 years after final payment under this contract, have access to and the right to examine any of the Contractor's directly pertinent books, documents, papers, or other records involving transactions related to this contract for the purpose of making audit, examination, excerpts, and transcriptions.
- (b) The Contractor agrees to include in first-tier subcontracts under this contract a clause substantially the same as paragraph (a) above. "Subcontract," as used in this clause, excludes purchase orders not exceeding \$10,000.
- (c) The periods of access and examination in paragraphs (a) and (b) above for records relating to (1) appeals under the Disputes clause of this contract, (2) litigation or settlement of claims arising from the performance of this contract, or (3) costs and expenses of this contract to which the PHA, HUD, or Comptroller General or any of their duly authorized representatives has taken exception shall continue until disposition of such appeals, litigation, claims, or exceptions.

46. Labor Standards – Davis-Bacon and Related

~~If the total amount of this contract exceeds \$2,000, the Federal labor standards set forth in the clause below shall apply to the development or construction work to be performed under the contract.~~

~~(a) Minimum Wages.~~

~~(1) All laborers and mechanics employed under this contract in the development or construction of the project(s) involved will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR Part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Contractor and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of 29 CFR 5.5(a)(1)(iv); also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the regular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits in the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein; provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under 29 CFR 5.5(a)(1)(ii) and the Davis-Bacon poster (WH-1321) shall~~

be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(2) (i) Any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. HUD shall approve an additional classification and wage rate and fringe benefits therefor only when all the following criteria have been met: (A) The work to be performed by the classification requested is not performed by a classification in the wage determination; and (B) The classification is utilized in the area by the construction industry; and (C) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(ii) If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and HUD or its designee agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by HUD or its designee to the Administrator of the Wage and Hour Division, Employee Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise HUD or its designee or will notify HUD or its designee within the 30-day period that additional time is necessary.

(iii) In the event the Contractor, the laborers or mechanics to be employed in the classification or their representatives, and HUD or its designee do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), HUD or its designee shall refer the questions, including the views of all interested parties and the recommendation of HUD or its designee, to the Administrator of the Wage and Hour Division for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise HUD or its designee or will notify HUD or its designee within the 30-day period that additional time is necessary.

(iv) The wage rate (including fringe benefits where appropriate) determined pursuant to subparagraphs (a)(2)(ii) or (iii) of this clause shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in classification.

(3) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the Contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(4) If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the

amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program; provided, that the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(b) Withholding of funds. HUD or its designee shall, upon its own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the Contractor under this contract or any other Federal contract with the same prime Contractor, or any other Federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime Contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working in the construction or development of the project, all or part of the wages required by the contract, HUD or its designee may, after written notice to the Contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased. HUD or its designee may, after written notice to the Contractor, disburse such amounts withheld for and on account of the Contractor or subcontractor to the respective employees to whom they are due.

(c) Payrolls and basic records.

(1) Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working in the construction or development of the project. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made, and actual wages paid. Whenever the Secretary of Labor has found, under 29 CFR 5.5(a)(1)(iv), that the wages of any laborer or mechanic include the amount of costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the Contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(2) (i) The Contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Contracting Officer for transmission to HUD or its designee. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under subparagraph (c)(1) of this clause. This information may be submitted in any form desired. Optional Form WH-347 (Federal Stock Number 029-005-00014-1) is available for this purpose and may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The Contractor is responsible for the submission of copies of payrolls by all subcontractors. (Approved by the Office of Management and Budget under OMB Control Number 1214-0149.)

(ii) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

- (A) That the payroll for the payroll period contains the information required to be maintained under paragraph (c) (1) of this clause and that such information is correct and complete;
- (B) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in 29 CFR Part 3; and
- (C) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(iii) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirements for submission of the "Statement of Compliance" required by subparagraph (c)(2)(ii) of this clause.

(iv) The falsification of any of the above certifications may subject the Contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 3729 of Title 31 of the United States Code.

(3) The Contractor or subcontractor shall make the records required under subparagraph (c)(1) available for inspection, copying, or transcription by authorized representatives of HUD or its designee, the Contracting Officer, or the Department of Labor and shall permit such representatives to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit the required records or to make them available, HUD or its designee may, after written notice to the Contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to

make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(d) (1) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship and Training, Employer and Labor Services (OATELS), or with a State Apprenticeship Agency recognized by OATELS, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by OATELS or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the Contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated in this paragraph, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the Contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator of the Wage and Hour Division determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event OATELS, or a State Apprenticeship Agency recognized by OATELS, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(2) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under

the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed in the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate in the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate in the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate in the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(3) Equal employment opportunity. The utilization of apprentices, trainees, and journeymen under this clause shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

- (e) Compliance with Copeland Act requirements. The Contractor shall comply with the requirements of 29 CFR Part 3, which are hereby incorporated by reference in this contract.
- (f) Contract termination; debarment. A breach of this contract clause may be grounds for termination of the contract and for debarment as a Contractor and a subcontractor as provided in 29 CFR 5.12.
- (g) Compliance with Davis-Bacon and related Act requirements. All rulings and interpretations of the Davis-Bacon and related Acts contained in 29 CFR Parts 1, 3, and 5 are herein incorporated by reference in this contract.
- (h) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this clause shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any of its subcontractors) and the PHA, HUD, the U.S. Department of Labor, or the employees or their representatives.
- (i) Certification of eligibility.
 - (1) By entering into this contract, the Contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the Contractor's firm is a person or firm ineligible to be awarded contracts by the United States Government by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

- (2) No part of this contract shall be subcontracted to any person or firm ineligible for award of a United States Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
- (3) The penalty for making false statements is prescribed in the U. S. Criminal Code, 18 U.S.C. 1001.
- (j) Contract Work Hours and Safety Standards Act. As used in this paragraph, the terms "laborers" and "mechanics" include watchmen and guards.
 - (1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics, including watchmen and guards, shall require or permit any such laborer or mechanic in any workweek in which the individual is employed on such work to work in excess of 40 hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of 40 hours in such workweek.
 - (2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the provisions set forth in subparagraph (j)(1) of this clause, the Contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such Contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic (including watchmen and guards) employed in violation of the provisions set forth in subparagraph (j)(1) of this clause, in the sum of \$27 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of 40 hours without payment of the overtime wages required by provisions set forth in subparagraph (j)(1) of this clause. DOL posts current fines at: <https://www.dol.gov/whd/govcontracts/cwhssa.htm#cmp>
 - (3) Withholding for unpaid wages and liquidated damages. HUD or its designee shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the Contractor or subcontractor under any such contract or any Federal contract with the same prime Contractor, or any other Federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime Contractor, such sums as may be determined to be necessary to satisfy any liabilities of such Contractor or subcontractor for unpaid wages and liquidated damages as provided in the provisions set forth in subparagraph (j)(2) of this clause.
- (k) Subcontracts. The Contractor or subcontractor shall insert in any subcontracts all the provisions contained in this clause, and such other clauses as HUD or its designee may by appropriate instructions require, and also a clause requiring the subcontractors to include these provisions in any lower tier subcontracts. The prime Contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all these provisions.

47. Non-Federal Prevailing Wage Rates

~~(a) Any prevailing wage rate (including basic hourly rate and any fringe benefits), determined under State or tribal law to be prevailing, with respect to any employee in any trade or position employed under the contract, is inapplicable to the contract and shall not be enforced against the Contractor or any subcontractor, with respect to employees engaged under the contract whenever such non-Federal prevailing wage rate exceeds:~~

~~(1) The applicable wage rate determined by the Secretary of Labor pursuant to the Davis-Bacon Act (40 U.S.C. 3141 et seq.) to be prevailing in the locality with respect to such trade;~~

~~(b) An applicable apprentice wage rate based thereon specified in an apprenticeship program registered with the U.S. Department of Labor (DOL) or a DOL-recognized State Apprenticeship Agency; or~~

~~(c) An applicable trainee wage rate based thereon specified in a DOL-certified trainee program.~~

48. Procurement of Recovered Materials.

(a) In accordance with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, the Contractor shall procure items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR Part 247 that contain the highest percentage of recovered materials practicable, consistent with maintaining a satisfactory level of competition. The Contractor shall procure items designated in the EPA guidelines that contain the highest percentage of recovered materials practicable unless the Contractor determines that such items: (1) are not reasonably available in a reasonable period of time; (2) fail to meet reasonable performance standards, which shall be determined on the basis of the guidelines of the National Institute of Standards and Technology, if applicable to the item; or (3) are only available at an unreasonable price.

() Paragraph (a) of this clause shall apply to items purchased under this contract where: (1) the

Contractor purchases in excess of \$10,000 of the item under this contract; or (2) during the preceding Federal fiscal year, the Contractor: (i) purchased any amount of the items for use under a contract that was funded with Federal appropriations and was with a Federal agency or a State agency or agency of a political subdivision of a State; and (ii) purchased a total of in excess of \$10,000 of the item both under and outside that contract.

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SPECIAL CONDITIONS TO CONTRACT

#25-C-0019

HEERAN CENTER HVAC SYSTEM UPGRADE

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SPECIAL CONDITIONS

HEERAN CENTER HVAC SYSTEM UPGRADE

1. PROJECT SITE:

The project site is located at 2222 Coburg Rd, Eugene, OR 97401.

2. TIME FOR COMPLETION:

The Agency expects to issue the **Notice to Proceed effective Monday, April 28, 2025**. After mobilization the Contractor will have **Two Hundred Forty-Three (243)** calendar days to complete the contract. **Final completion is expected no later than Friday, December 26, 2025.**

3. The Contractor is responsible for the basic Permit fee, the Contractor will be responsible for any/all inspections, and associated fees.

The Agency will reimburse the Contractor for all fees.

Do not include plan review, permitting, or inspection fees in your Bid.

4. LIQUIDATED DAMAGES:

If a contractor fails to complete the work within the time specified in the contract, or any extension, as specified in the clause entitled Default of Contract, the Contractor shall pay to the Agency as liquidated damages, the sum of \$50.00 per calendar day of delay.

5. COMMUNICATIONS:

All notices, demands, requests, instructions, approvals, proposals, and claims must be in writing and forwarded to the Contract Administrator.

6. MINIMUM RATE OF PAY:

BOLI Wage Rates

A schedule of the minimum rate of pay applicable to all work performed under this contract is in Section 00826. Instructions for payroll reporting and forms will also be presented at the Preconstruction Meeting.

7. DRAWINGS INDEX

SHEET G001	Cover Sheet- Contacts, Vicinity Map, Site Map, Sheet List.
SHEET M001:	Legend, General Notes, Sheet List
SHEET M101:	Demolition Plan
SHEET M102:	Demolition Roof Plan
SHEET M121:	Mechanical Air Distribution Plan

SHEET M122:	Mechanical Roof Plan
SHEET M131:	Mechanical Piping Plan
SHEET M421:	Mechanical Room Enlargement Plans
SHEET M501:	Details
SHEET M601:	Schedules
SHEET M611:	Diagrams
SHEET M701:	Zone Plan
SHEET E001:	Legend, General Notes, Sheet List
SHEET E101:	Demolition Plan
SHEET E102:	Demolition Roof Plan
SHEET E121:	Floor Plans
SHEET E122:	Electrical Roof Plan
SHEET E601:	Schedules
SHEET E611:	Diagrams

8. TIME SCHEDULE FOR SUBMITTALS:

		ARCHITECT/ OWNER REVIEW IN	CONTRACTOR UPDATE & RESUBMIT
FIRST SUBMITTAL			
Construction Schedule	At time of Pre-construction Meeting	7 Days	3 Days
Schedule of Values (On Approved Form)	At time of Pre-construction Meeting	7 days	5 days
Subcontractor List & Major Products List	At time of Pre-construction Meeting	7 days	As Needed
Certificates, Product Data, etc.	10 days prior to ordering	5 days	2 days

9. CONSTRUCTION SCHEDULE:

At a mutually agreed upon schedule between the Contractor and Homes for Good, work will initiate. Once work initiates, all work shall be completed within **Two Hundred Forty-Three (243)** calendar days.

At the Pre-construction Meeting, the Awarded Contractor shall submit to the Contract Administrator a scheduled work program. Updates should be submitted as necessary. The schedule shall include the starting and completion dates of the following:

- a. Work outline: With time for major work sequences detailed in a time schedule.
- b. Substantial Completion Date
- c. Final Completion Date

10. SUBMISSION OF SUBCONTRACTORS LIST

At the Pre-construction Meeting, the Contractor shall submit a complete list of proposed installing subcontractors. When requested by owner, Contractor shall provide written information on experience and list of previous projects by subcontractors, suppliers, and manufacturers. See Specifications Sections.

11. SUBMISSION OF SUBCONTRACTOR AGREEMENTS:

The awarded General Contractor shall provide a completed and signed Contractor/Subcontractor Contract Agreement form for each Subcontractor. The Contractor/Subcontractor Contract Agreement form can be found in the Sample Forms section of the Project Manual.

12. PRE-CONSTRUCTION MEETING:

Contract Administrator will schedule a Pre-construction Meeting, before Notice to Proceed, but no later than seven (7) calendar days after the Notice to Proceed date has been issued.

Attendance: Owner's Representative, Architect/Engineer, Contractor and major subcontractors.

Minimum Meeting Agenda: Distribute and discuss list of subcontractors, construction schedule, processing of field decisions, procedures for maintaining record documents, use of premises, storage areas, security, deliveries, safety, parking, housekeeping, and first aid requirements. The HUD procedures for compliance with Executive Orders concerning Equal Opportunity and Labor Provisions will be discussed.

13. PROGRESS MEETINGS, AND PROJECT RECORD KEEPING:

The Contract Administrator, in coordination with the General Contractor, may schedule meetings and firm dates with parties involved, as agreed. Contract Administrator will preside at meetings.

- Frequency: Regular Meetings as required.
- Attendance: Owner's representative, Architect/Engineer, Contractor, subcontractors affected by agenda.

Minimum Agenda: Review decisions from previous meetings, progress since previous meeting, work to be executed following week, construction and delivery schedule, field observations, problems, proposed changes, and identify problems which impede scheduled progress.

The Contractor is to keep a Daily Log of the project. Contractor shall provide copy of contractor's daily log to owner for his files. Include the following information in the logs – *(continued)*

- | | |
|--------------------------------------|-------------------------------|
| 1. Work Completed | 5. Testing |
| 2. Sub-Contractors working | 6. Inspections |
| 3. Total number of employees working | 7. Products delivered to site |
| 4. Visitors to the site | 8. Weather conditions |

14. RECORD DRAWINGS:

Contractor to provide location on Drawings of underground utilities encountered during the project.

15. CONTRACTOR USE OF PREMISES:**A. Hours of Work:**

Contractor is free to work between the hours of 8:00 am and 5:00 PM, Monday through Friday. Weekend work or extended hours of work will be allowed only with prior written authorization by the Contract Administrator.

B. Legal Holidays:

The Contractor is not to work on Federal legal holidays. For the purpose of this contract,

the legal holidays are: **All Federal Holidays**

C. Temporary Water and Power:

Temporary water and electricity (120 volt low-amp circuit) are available at the site. The Contractor shall be responsible to provide safe and effective temporary power connections at locations approved with Owner. Electricity and water shall be paid by the Owner to the extent required to perform the work. Wasted utilities shall be paid by the Contractor.

D. Existing Utilities:

Each contractor shall become familiar with the existing utilities associated with the project work as to their locations and shall coordinate with the local utilities prior to any excavations.

All costs incurred by the contractor in locating and protecting existing utilities that are directly related to the construction activities shall be included in the lump sum indicated on the Bid Form.

E. Resident Notification:

Homes for Good will notify tenants of work being performed.

F. Toilet Facilities:

The Contractor shall provide and service temporary portable toilet facilities at no additional cost to the owner.

G. Contractor's On-Site Phone and Office:

The Contractor is responsible to provide a means of communication by which the Contract Administrator may reach him/her at all times during normal working hours by phone.

- a) There is no office space or phone service available on the site for the Contractor's use.
- b) The Contractor may erect, at his/her option, a temporary field office on the site, within the construction limits of the job (the location to be coordinated with the Contract Administrator).
- c) The phone may be mobile - but must be available at the site during all times work is performed.

H. Demolition and Garbage Collection:

Contractor shall either provide a dumpster / drop box for debris or shall daily collect and haul demolition debris off site. No debris will be allowed to accumulate. All disposal fees shall be the responsibility of the contractor.

I. Site Access and Fire Egress:

The Contractor shall keep access roads, parking areas, and loading areas clear. The Contractor shall be responsible to provide barricades, warning signs, flagmen or other traffic regulators as necessary, and where required by local ordinance. Contractor shall assure that access and egress for neighboring properties is available at all times. Should disruption be unavoidable, contractor shall provide alternative access routes and directional signage. Contractor shall assure that fire escape (egress) for this property is clear of all material, equipment, debris, and work related items under their control, at all times.

J. Contractor Parking:

Contractor and Sub-contractor parking is available at the project work site. Coordinate with Contract Administrator.

- K. Work Areas:**
Contractor will confine operations to areas immediately adjacent to the work being constructed or performed and other areas as acceptable to the Owner.
- L. Job Site Fence:**
If a fence is considered necessary by the Contractor, coordinate location with the Contract Administrator.
- N. Materials Storage Area:** Coordinate with Contract Administrator
- O. Off-Site Materials Storage:**
Contractor shall obtain and pay for the use of additional storage or work areas needed for operation. Off-site storage of products under this contract shall be held at a bonded facility in the Eugene/Springfield Metro area or other location approved by the Contract Administrator if payment for materials, prior to installation, is requested. The Contract Administrator shall be informed of the location in writing, and shall be provided access to the off-site storage to determine the protection and safekeeping of said products prior to payment for the products, and at times prior to their installation.

16. SAFETY OF PERSONS AND PROPERTY

- A.** The Contractor shall be solely responsible for conditions of the job site, including safety of all persons and property during the performance of the Work. This requirement shall apply continuously, at all times, and not be limited to normal working hours.
- The duty of the Owner's representatives and agents are to conduct review of the Contractor's construction product and not intended to include review of the adequacy of the Contractor's safety measure in, on, or near the construction site.
- B.** Storage or use of explosives or other hazardous materials or unusual methods of construction are forbidden on Agency property without written request from the Contractor sent by certified mail, 30 days prior to their proposed use, and are forbidden without written approval from the Contract Administrator.
- C.** The Contractor shall provide temporary fencing, barricades, and other items necessary to provide safe and secure worksite areas. Contractor shall provide barricades, warning signs, flagmen, or other traffic regulators as required by local ordinance and governing agencies.
- D.** The Contractor shall provide ABC type emergency fire extinguishers of adequate quantity, readily available and properly maintained. Each contractor shall take precautions to prevent the possibility of fire resulting from construction operations, hazardous accumulations of rubbish and unsecured flammable materials.
- E.** The Contractor shall provide first aid facilities for construction personnel.
- F.** The Contractor shall cover and protect construction materials stored at the site.
- Contractor shall assume full responsibility for the protection and safekeeping of products under this contract, stored on the site; coordinate on-site storage locations and security with the Contract Administrator.
- G.** Contractor shall assume full responsibility against theft or damage of products and materials under this contract.

**17. CHANGE ORDER PROCESSING PROCEDURES:
Refer to HUD General Conditions Section 00710, Articles 28 and 29.**

The Contractor shall provide a complete cost accounting, and indicate new date of Substantial Completion if required due to the Change Order.

Contractor shall submit a written itemized list of labor and materials, and separate itemization for overhead and profit, with each Construction Change Order of all increases and decreases to the Contract.

The itemized breakdown shall include;

- a) A detailed list of labor (hours and labor rates),
- b) Actual costs for materials (each item and quantity), with invoices or written quotes,
- c) Other actual costs required due to the change (shipping, equipment rental, etc.),
- d) Itemization of any sub-contractor costs. All Sub-contractor costs shall have the same, complete, itemized cost breakdowns, in written form, and shall be included in the proposed Change Order cost.
- e) Plus a maximum of twenty percent (20%) allowable indirect costs (overhead) and profit. The Contractor's overhead and profit shall be limited to a combined twenty percent (20%) of the allowable costs.
- f) The Contractor shall not be allowed a profit on the profit received by any subcontractor.

Contractor shall submit additional copies of invoices, written quotes, and estimating sheets upon request of owner.

Contractor shall submit two signed copies of each Construction Change Order to the owner.

The Owner's Representative will authorize, **in writing, all** changes to the work and contract value. No change to the work is to progress until written approval is received by the Contractor and signed by the Contract Administrator. *No verbal communications will authorize changes to the Specifications, Drawings, Work, Values, Time, or Contract.*

An approved Change Order, signed by the Contract Administrator means that the work may proceed and payment for accepted work shall be made upon inclusion in a Contract Modification and proper billing.

The Owner will combine Approved Change Orders into a formal Contract Modification approximately once a month. The Contract Modification shall adjust the Contract Sum or Contract Time as applicable. The Contract Modification shall be signed by the Contractor and the Executive Director of Homes for Good Housing Agency, prior to billing.

**18. SUPERVISION:
Refer to HUD General Conditions Section 00710, Article 2, paragraph (c).**

A Contractor's representative shall be present or be duly represented at the site at all times when work is actually in progress by the Contractor's own employees, or any subcontractor or subcontractor's employees.

The Contractor's representative shall not be withdrawn from the work without due notice being given in writing. A competent replacement shall be named in writing and a timely change over

accomplished so as not to impede the progress of the work.

The Contractor may authorize, in writing, a Subcontractor to work on the site as the Contractor's representative. In this case, the written authorization must be received prior to the original Contractor's representative being absent from the site. The Subcontractor is then representing the Contractor on the work site, and is the Contractor's representative.

All requirements, instructions and other communications given to the authorized representative by the Contract Administrator, shall be binding as if given to the Contractor.

The Contract Administrator may, in writing, require the Contractor to remove from the work any employee whom the Contract Administrator deems incompetent, careless, insubordinate, or otherwise objectionable or whose continued employment on the work is deemed by the Contract Administrator to be contrary to the Owner's interest.

19. WARRANTIES AND BONDS:

For equipment or component parts of equipment put into service during progress of construction, Contractor shall submit documents within 10 days after inspection and acceptance.

Other than the above item, Contractor shall make submittals within two days after date of substantial completion, prior to final request for payment.

For items of work, where acceptance is delayed materially beyond the date of Substantial Completion, Contractor shall provide updated submittal within ten days after acceptance listing the date of acceptance as the start of the warranty period.

Where items of the work require warranties, the final payment for that work will not be made until the warranty is submitted and approved.

20. EXISTING HAZARDOUS MATERIALS:

If during the project work, the Contractor discovers materials which the Contractor suspects are hazardous, the Contractor shall immediately clear and secure the worksite, and shall immediately contact the Architect and Contract Administrator in writing.

- a) The Owner shall obtain the services of a licensed environmental testing service to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to verify that it has been rendered harmless. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor.
- b) If after testing the materials reported by the Contractor, hazardous materials are found, that were not identified in the Documents as hazardous, the Contract Time shall be extended appropriately and the Contract Sum shall be increased in the amount of the Contractors' reasonable additional costs of shut-down, delay, and start-up which shall be documented as provided in Article 17 of the Special Conditions.
- c) If after testing the materials reported by the Contractor, hazardous materials are not found, that were not identified in the Documents as hazardous, the Contract Time shall not be extended and the Contract Sum shall not be increased due to Contractors' additional costs of shut-down, delay, and/or start-up.

21. PLANTS, TREES, AND GRASSES:

Work may require the displacement of plants and trees. Where displacement is necessary, the

Contractor is to carefully remove, store and replace materials, according to highest industry standards. Work shall be verified and coordinated with the Contract Administrator, prior to removal.

22. EXTERIOR AREAS:

All areas of gravel, asphalt, mulch, flatwork, fences, sidewalks, curbs, lawns or landscaping disturbed or destroyed resulting from the contract work shall be returned to the original condition or better.

23. DRUG FREE WORK ENVIRONMENT

All contractors and employees of contractors will maintain a drug free environment when performing work on or at the Agency location under contract. Refer to Section 00020 for further instructions.

END OF SECTION

SECTION 011000
SUMMARY OF WORK

PART 1 GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Work covered by Contract Documents.
- B. Contract Method.
- C. Contractor's use of site and premises.
- D. Owner Occupancy.
- E. Sequence of Work.
- F. Coordination with occupants.
- G. Work restrictions.
- H. Specification and Drawing conventions.

1.2 DEFINITIONS

- A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Title: Heeran Center HVAC System Upgrade
- B. Owner: Jared Young, Homes for Good, 100 West 13th Avenue, Eugene, OR 97401.
- C. Engineer: Systems West Engineers, 725 A Street, Springfield, OR 97477.
- D. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:
 - 1. Replace existing watersource heat pumps, boilers, cooling tower, building automation system, associated electrical requirements, provide new makeup air unit, and other work indicated in the Contract Documents.
- E. Permits and Fees:
 - 1. The Owner is responsible for filing and paying for building permits and fees associated with the building permit.
 - 2. The Contractor is responsible for obtaining all Project construction permits and will have full responsibility for requirements of and obtaining all trade permits (i.e. mechanical, electrical, plumbing, and pressure vessel). Owner will provide reimbursement for for permit fees.

1.4 CONTRACT METHOD

- A. Work will be constructed under a single lump sum contract.

1.5 CONTRACTOR USE OF SITE AND PREMISES

- A. Restricted Use of Site: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. Limits on Use of Site: Limit use of Project site to Work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 - 1. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
 - c. Areas that can be accessed by residents or in the Lane County Probation wing will require contractors to be accompanied by a Columbia Care staff member. See Drawings for areas.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

1.6 OWNER OCCUPANCY

- A. Areas near and adjacent to work under this Contract are currently occupied. Owner will occupy premises during the entire construction period for performance of normal operations. Cooperate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.7 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy Project site and existing building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 - 2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

1.8 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.

- B. On-Site and work in existing building Hours: Limit work to between 8 a.m. to 5 p.m, Monday through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner and authorities having jurisdiction.
 - 1. Weekend Hours: Weekend work will be allowed only with prior written authorization by the Contract Administrator.
 - 2. Early Morning Hours: Extended hours of work will be allowed only with prior written authorization by the Contract Administrator.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:
 - 1. Notify Contract Administrator not less than 72 hours in advance of proposed utility interruptions.
 - 2. Obtain Contract Administrator's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
 - 1. Notify Contract Administrator not less than hours in advance of proposed disruptive operations.
 - 2. Obtain Contract Administrator's written permission before proceeding with disruptive operations.
- E. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances on Owner's property is not permitted.
- F. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
 - 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
 - 4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings and published as part of the U.S. National CAD Standard.
 3. Keynoting/Reference Notes: Materials and products are identified by reference notes referencing Specification Section numbers found in this Project Manual.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SUBSTITUTION REQUEST FORM

TO: _____

PROJECT: _____

SPECIFIED ITEM:

Section	Page	Paragraph	Description
---------	------	-----------	-------------

The undersigned requests consideration of the following:

PROPOSED SUBSTITUTION: _____

Attached data includes product description, specifications, drawings, photographs, performance, and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes description of changes to Contract Documents which proposed substitution will require for its proper installation.

The undersigned states that the following paragraphs, unless modified on attachments, are correct:

1. The proposed substitution does not affect dimensions shown on Drawings.
2. The undersigned will pay for changes to the building design, including engineering design, detailing and construction costs caused by the requested substitution.
3. The proposed substitution will have no adverse effect on other trades, the construction schedule, or specified warranty requirements.
4. Maintenance and service parts will be locally available for the proposed substitution.

The undersigned further states that the function, appearance, and quality of the Proposed Substitution are equivalent or superior to the Specified Item.

Submitted by:

Signature _____

For use by Design Consultant:

Firm _____

Accepted Accepted as noted

Address _____

Not Accepted Received too late

_____ By: _____

Date _____ Date: _____

Telephone _____ Remarks: _____

Attachments:

SECTION 012500

SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner.

1.3 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use form provided in Project Manual.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - d. Certificates and qualification data, where applicable or requested.
 - e. List of similar installations for completed projects, with project names and addresses as well as names and addresses of engineers and owners.
 - f. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - g. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
 - 3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within five days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within ten days of receipt of request, or seven days of receipt of additional information

or documentation, whichever is later.

- a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
- b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.5 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.6 SUBSTITUTIONS DURING BIDDING

- A. Submit two (2) copies of the following information with each request to Engineer and Owner's Contract Administrator.
- B. Substitution request form included in Project Manual, at end of Section 012500.
 1. Comparison of proposed substitution with product, material or system specified.
 2. Complete data, substantiating compliance of proposed substitution with the Contract.
 3. Documents.
 4. Test numbers and supporting reports, indicating compliance with referenced standards.
 5. Evidence that warranty requirements are acceptable.
 6. Details indicating specific deviations proposed for the substitution.
 7. Reference and applicable Specification sections.
- C. Substitution requests must be received by Engineer's office no less than ten (10) calendar days before bid closing. Requests received after this date will not be considered.

1.7 SUBSTITUTIONS DURING CONSTRUCTION

- A. Substitutions will normally not be considered after date of Contract except when required due to unforeseen circumstances.
- B. One or more of the following conditions must be documented and substantiated in any such request:
 1. Specified product is no longer available.
 2. Specified product is no longer compatible, due to changes in the design during construction.
 3. A change in governing regulatory requirements makes a revision in design or material usage mandatory.
 4. Substitution offers the owner a substantial advantage in cost, time, energy conservation, or other considerations (provide substantiation for review).
- C. Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied,

Engineer will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- b. insert sustainable design text for requested substitution.
- c. Substitution request is fully documented and properly submitted.
- d. Requested substitution will not adversely affect Contractor's construction schedule.
- e. Requested substitution has received necessary approvals of authorities having jurisdiction.
- f. Requested substitution is compatible with other portions of the Work.
- g. Requested substitution has been coordinated with other portions of the Work.
- h. Requested substitution provides specified warranty.
- i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

1.8 SUBSTITUTIONS NOT PERMITTED

- A. If implied on submittals without first requesting approval thereof.
- B. If acceptance will require substantial revision of the Contract Documents.
- C. Substitutions for convenience.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 012600

CONTRACT CLARIFICATION AND MODIFICATION PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications, including the following:
 - 1. Requests for Information.
 - 2. Proposals for changes in work.
 - 3. Supplemental Instructions.
 - 4. Proposal Requests.
 - 5. Field Orders.
 - 6. Change Orders.
 - 7. Construction Change Directives.
- B. Related Requirements:
 - 1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.
 - 2. Section 01 31 00 "Project Management and Coordination" for requirements for forms for contract modifications provided as part of web-based Project management software.

1.2 DEFINITIONS

- A. RFI: Request for Information. Request from Contractor seeking information required by or clarifications of the Contract Documents.
- B. Proposal Request: An itemized labor and material quotation for proposed changes to the Work that need written approval on cost prior to proceeding.
- C. Field Order: Written order, instruction, or project manual interpretation issued by Engineer to Contractor which authorizes minor changes to Work which do not alter Contract Sum or Contract Time.
- D. Supplemental Instruction: A written order issued by the Engineer to issue additional instructions or interpretations, or to issue Minor Changes to the Work.
- E. Change Order: As defined in the General Conditions and signed by Owner, Contractor, and Engineer.
- F. Construction Change Directive: Written order to Contractor signed by Owner, Contractor, and Engineer which authorizes changes in the Work which affect the Contract Sum or Contract Time. A Construction Change Directive will be issued involving changes in the Work which, if not processed quickly, might delay the project. A Construction Change Directive will be followed by a Change Order.

1.3 REQUESTS FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Owner name.
 3. Owner's Project number.
 4. Name of Engineer and Owner's Contract Administrator.
 5. Engineer's Project number.
 6. Date.
 7. Name of Contractor.
 8. RFI number, numbered sequentially.
 9. RFI subject.
 10. Specification Section number and title and related paragraphs, as appropriate.
 11. Drawing number and detail references, as appropriate.
 12. Field dimensions and conditions, as appropriate.
 13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 14. Contractor's signature.
 15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Engineer.
1. Attachments shall be electronic files in PDF format.
- D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.
 3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."

- a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within 5 days of receipt of the RFI response.

1.4 SUPPLEMENTAL INSTRUCTIONS

- A. Engineer will issue Supplemental Instructions authorizing minor changes in the Work, on Supplemental Instruction document. Where a change in Contract Sum or Contract Time is required, provide written response identifying amounts prior to proceeding.

1.5 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 1. Work Change Proposal Requests issued by Engineer are not instructions either to stop work in progress or to execute the proposed change.
 2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - e. Quotation Form: Use Contractor standard form.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Engineer and and Owner's Contract Administrator.
 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 4. Include costs of labor and supervision directly attributable to the change.
 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 6. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
 7. Proposal Request Form: Use Contractor standard form..

1.6 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Engineer and and Owner's Contract Administrator will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.7 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Engineer and Owner's Contract Administrator may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 - 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 012900

PAYMENT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.

1.2 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.3 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Engineer Owner's Contract Administrator at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Owner's name.
 - c. Owner's Project number.
 - d. Name of Engineer.
 - e. Engineer's Project number.
 - f. Contractor's name and address.
 - g. Date of submittal.
 - 2. Arrange schedule of values consistent with format of AIA Document G703.
 - 3. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to

whole dollars, with total equal to Contract Sum.

- 1) Labor.
 - 2) Materials.
 - 3) Equipment.
4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
 5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site.
 6. Overhead Costs, Proportional Distribution: Include total cost and proportionate share of general overhead and profit for each line item.
 7. Overhead Costs, Separate Line Items: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
 8. Temporary Facilities: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
 9. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
 10. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.4 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments, as certified by Engineer and paid for by Owner.
- B. Payment Application Times: The date for each progress payment is indicated in the Owner/Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Times: Submit Application for Payment to Engineer by the 5th of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.
- D. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Engineer will return incomplete applications without action.
 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.

- F. **Stored Materials:** Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- G. **Transmittal:** Submit signed and notarized electronic copies of each Application for Payment to Engineer and and Owner's Contract Administrator .. Include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- H. **Initial Application for Payment:** Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
 5. Products list (preliminary if not final).
 6. Submittal schedule (preliminary if not final).
 7. List of Contractor's staff assignments.
 8. List of Contractor's principal consultants.
 9. Copies of building permits.
 10. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 11. Initial progress report.
 12. Report of preconstruction conference.
 13. Certificates of insurance and insurance policies.
 14. Performance and payment bonds.
 15. Data needed to acquire Owner's insurance.
- I. **Application for Payment at Substantial Completion:** After Engineer issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 01 77 00 "Closeout Procedures."
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

- J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Certification of completion of final punch list items.
 3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 4. Updated final statement, accounting for final changes to the Contract Sum.
 5. AIA Document G706.
 6. AIA Document G706A.
 7. AIA Document G707.
 8. Evidence that claims have been settled.
 9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 10. Final liquidated damages settlement statement.
 11. Proof that taxes, fees, and similar obligations are paid.
 12. Waivers and releases.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 013100

PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Digital project management procedures.
 - 3. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Section 01 26 00 "Contract Clarification and Modification Procedures" for preparing and issuing RFIs.
 - 2. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 3. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 4. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.

1.2 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, mobile telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1.3 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.

2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.

1.4 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Engineer's Digital Data Files: Digital data files of Engineer's BIM model will be provided by Engineer for Contractor's use during construction.
1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
 2. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 3. Digital Drawing Software Program: Contract Drawings are available in Revit.
 4. Contractor shall execute a data licensing agreement in the form of Agreement form from Engineer.
 - a. Subcontractors and other parties granted access by Contractor to Engineer's digital data files shall execute a data licensing agreement in the form of Agreement form from Engineer.

1.5 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner's Contract Administrator and Engineer of scheduled meeting dates and times a minimum of seven days prior to meeting.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner's Contract Administrator and Engineer, within three days of the meeting.
- B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner Engineer; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.

- b. Tentative construction schedule.
 - c. Work sequencing and long lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Preparation of Record Documents.
 - m. Use of the premises and existing building.
 - n. Work restrictions.
 - o. Working hours.
 - p. Owner's occupancy requirements.
 - q. Responsibility for temporary facilities and controls.
 - r. Procedures for moisture and mold control.
 - s. Procedures for disruptions and shutdowns.
 - t. Construction waste management and recycling.
 - u. Parking availability.
 - v. Office, work, and storage areas.
 - w. Equipment deliveries and priorities.
 - x. First aid.
 - y. Security.
 - z. Progress cleaning.
3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Engineer, but no later than 45 days prior to the scheduled date of Substantial Completion.
- 1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 - 2. Attendees: Authorized representatives of Owner, Owner's Contract Administrator, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for completing sustainable design documentation.
 - f. Requirements for preparing operations and maintenance data.
 - g. Requirements for delivery of material samples, attic stock, and spare parts.
 - h. Requirements for demonstration and training.
 - i. Preparation of Contractor's punch list.
 - j. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - k. Submittal procedures.
 - l. Coordination of separate contracts.
 - m. Owner's partial occupancy requirements.

- n. Installation of Owner's furniture, fixtures, and equipment.
 - o. Responsibility for removing temporary facilities and controls.
 - 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- D. Progress Meetings: Conduct progress meetings at biweekly intervals.
- 1. Coordinate dates of meetings with preparation of payment requests.
 - 2. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Status of sustainable design documentation.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site use.
 - 9) Temporary facilities and controls.
 - 10) Progress cleaning.
 - 11) Quality and work standards.
 - 12) Status of correction of deficient items.
 - 13) Field observations.
 - 14) Status of RFIs.
 - 15) Status of Proposal Requests.
 - 16) Pending changes.
 - 17) Status of Change Orders.
 - 18) Pending claims and disputes.
 - 19) Documentation of information for payment requests.
 - 4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- E. Coordination Meetings: Conduct Project coordination meetings at biweekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
- 1. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Review and correct or approve minutes of the previous coordination

meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

- a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site use.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Status of RFIs.
 - 15) Proposal Requests.
 - 16) Change Orders.
 - 17) Pending changes.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 013300
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Submittal schedule requirements.
 - 2. Administrative and procedural requirements for submittals.

- B. Related Requirements:
 - 1. Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Section 01 31 00 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
 - 3. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 4. Section 01 40 00 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
 - 5. Section 01 77 00 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
 - 6. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 7. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

- B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.3 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 - 2. Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in status and timing for submittals.
4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Engineer's final release or approval.
 - g. Scheduled date of fabrication.

1.4 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
 1. Project name.
 2. Date.
 3. Name of Engineer.
 4. Name of Construction Manager.
 5. Name of Contractor.
 6. Name of firm or entity that prepared submittal.
 7. Names of subcontractor, manufacturer, and supplier.
 8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
 9. Category and type of submittal.
 10. Submittal purpose and description.
 11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
 12. Drawing number and detail references, as appropriate.
 13. Indication of full or partial submittal.
 14. Location(s) where product is to be installed, as appropriate.
 15. Other necessary identification.
 16. Remarks.
 17. Signature of transmitter.
- B. Options: Identify options requiring selection by Engineer.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.5 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

- B. All submittals shall be provided electronically except where specifically approved by the Engineer and and Contract Administrator.
1. Email: Prepare submittals as PDF package and transmit to Engineer by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Engineer.
 - a. The Engineer and and Contract Administrator will be identified during the pre-construction conference. Deliver all submittals electronically in PDF format to Engineer and and Contract Administrator at e-mail address provided at that time. Transmit each item with approved transmittal form referencing the project, the Owner, and the Contractor.
 - b. Engineer will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
 2. The Engineer and and Contract Administrator will be identified during the pre-construction conference. Deliver all submittals electronically in PDF format to Engineer and using file sharing software such as Dropbox.com, Egnyte, Newforma, or Microsoft OneDrive.
- C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- D. Engineers' Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.
1. Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings, Delegated Design Documents, and Project Record Documents as applicable.
 - a. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Digital Drawing Software Program: The Contract Drawings are available in Revit 2025.
 - c. Contractor shall execute a data licensing agreement on a form provided by Engineer.
- E. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's and receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow five (5) days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow five (5) days for review of each resubmittal.

- F. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.

- G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.

- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installer's, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

- I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.

- B. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.

- C. Qualification Data: Prepare written information that demonstrates capabilities and

experience of firm or person. Include lists of completed projects with project names and addresses, contact information of engineers and owners, and other information specified.

- D. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- E. Certificates:
1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
 5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
 6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.
- F. Test and Research Reports:
1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
 2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
 3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
 4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
 5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
 6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.

- f. Test procedures and results.
- g. Limitations of use.

1.7 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Engineer.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer and Contract Administrator.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - 1. Engineer and Contract Administrator will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ENGINEER'S AND CONSTRUCTION MANAGER'S REVIEW

- A. Action Submittals: Engineer and Contract Administrator will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate:
 - 1. No exceptions taken: No exceptions taken indicates the product has been reviewed and has been determined to be in general conformance with the intent of the Contract Documents.
 - 2. Make Corrections Noted: Make Corrections Noted indicates that there are no exceptions taken provided that the noted revisions, clarifications, coordination, or confirmation is carried out. A subsequent submittal of the product is not required and will not be reviewed.
 - 3. Revise and Resubmit: Revise and Resubmit indicates the product is not accepted. Contractor shall provide a complete re-submittal addressing issues and providing additional information as noted.
 - 4. Submittal not Received: Submittal not Received indicates that a submittal for the product has not been provided or reviewed. The notification is provided to the Contractor as a courtesy. It is the Contractor's responsibility to provide specified submittals and to revise and resubmit them as required to obtain approval prior to construction.
 - 5. Incomplete, not Reviewed: Incomplete, not Reviewed indicates that the submittal is largely inadequate and clearly does not provide the required information. The

- submittal has been rejected without review. Contractor shall provide a complete re-submittal in the correct format and including the information required.
6. Rejected: Rejected indicates the submittal is not correctly formatted or contains significant information that is not relevant. The submittal has been rejected without review. Contractor shall remove extraneous material from the submittal provide a complete re-submittal in the correct format and include only the information required.
 7. Informational Submittals: Engineer and Construction Manager will review each submittal and will not return it or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- B. Informational Submittals: Engineer and Contract Administrator will review each submittal and will not return it or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
 - C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.
 - D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
 - E. Engineer and Contract Administrator will return without review submittals received from sources other than Contractor.
 - F. Submittals not required by the Contract Documents will be returned by Engineer without action.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 014000
QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.2 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

- F. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Engineer.

1.3 DELEGATED DESIGN SERVICES

- A. Contractor may be required to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.
- B. Contractor shall cause such delegated professional design services to be provided by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.
- C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.
- D. Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor will be only for the following limited purposes:
 - 1. Confirming that Contractor has used the performance and design criteria specified in the Contract Documents.
 - 2. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.
- E. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.
- F. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.4 CONFLICTING REQUIREMENTS

- A. **Conflicting Standards and Other Requirements:** If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Engineer regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Engineer for clarification before proceeding.
- B. **Minimum Quantity or Quality Levels:** The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.5 INFORMATIONAL SUBMITTALS

- A. **Contractor's Quality-Control Plan:** For quality-assurance and quality-control activities and responsibilities.
- B. **Qualification Data:** For Contractor's quality-control personnel.
- C. **Contractor's Statement of Responsibility:** When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. **Testing Agency Qualifications:** For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized administrator.
- E. **Schedule of Tests and Inspections:** Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- F. **Reports:** Prepare and submit certified written reports and documents as specified.
- G. **Permits, Licenses, and Certificates:** For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.6 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.

- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 - 1. Name, address, telephone number, and email address of technical representative making report.
 - 2. Statement on condition of substrates and their acceptability for installation of product.
 - 3. Statement that products at Project site comply with requirements.
 - 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 6. Statement of whether conditions, products, and installation will affect warranty.
 - 7. Other required items indicated in individual Specification Sections.

- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
 - 1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 - 2. Statement that equipment complies with requirements.
 - 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 4. Statement of whether conditions, products, and installation will affect warranty.
 - 5. Other required items indicated in individual Specification Sections.

1.7 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
 - 1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1.8 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 2. Engage a qualified testing agency to perform quality-control services.

- a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Engineer, Contract Administrator, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.
- E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."
- F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspection equipment at

Project site.

- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.
 - 1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
 - 2. Distribution: Distribute schedule to Owner, Engineer, Contract Administrator, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.9 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
 - 1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 - 2. Notifying Engineer, Contract Administrator, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 - 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer, and Contract Administrator, with copy to Contractor and to authorities having jurisdiction.
 - 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 - 5. Interpreting tests and inspections and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
 - 6. Retesting and reinspecting corrected Work.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 - 1. Date test or inspection was conducted.
 - 2. Description of the Work tested or inspected.
 - 3. Date test or inspection results were transmitted to Engineer.
 - 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's and Contract Administrator's and authorities' having jurisdiction reference during normal working hours.
 - 1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

SECTION 015000

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

1.2 INFORMATIONAL SUBMITTALS

- A. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
 - 1. Locations of dust-control partitions at each phase of work.
 - 2. HVAC system replacement sequencing drawing.
 - 3. Location of proposed air-filtration system discharge.
 - 4. Waste-handling procedures.
 - 5. Other dust-control measures.
- B. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by the Owner. Include the following:
 - 1. Methods used to meet the goals and requirements of the Owner.
 - 2. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
 - 3. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with the Owner.

1.3 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.4 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 PRODUCTS

2.1 TEMPORARY FACILITIES

- A. Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading, as determined as required by Contractor. A location on site will be arranged by Contract Administrator.

2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 01 10 00 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

- A. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- B. Electric Power Service: If required for portable field office, connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
 - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - 1. Comply with work restrictions specified in Section 01 10 00 "Summary."

3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 - 2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

END OF SECTION

SECTION 016000

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary" for Contractor requirements related to Owner-furnished products.
 - 2. Section 01 25 00 "Substitution Procedures" for requests for substitutions.
 - 3. Section 01 77 00 "Closeout Procedures" for submitting warranties.

1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
 - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
 - 1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other

requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
 - 1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
 - 2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 01 33 00 "Submittal Procedures."
- F. Substitution: Refer to Section 01 25 00 "Substitution Procedures" for definition and limitations on substitutions.

1.3 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
 - 1. Resolution of Compatibility Disputes between Multiple Contractors:
 - a. Contractors are responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - b. If a dispute arises between the multiple contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
 - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.
 - 3. See individual identification Sections in Divisions 23 and 26 for additional equipment identification requirements.

1.4 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written

instructions.

- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.

- C. Storage:
 - 1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
 - 2. Store products to allow for inspection and measurement of quantity or counting of units.
 - 3. Store materials in a manner that will not endanger Project structure.
 - 4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
 - 5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 7. Protect stored products from damage and liquids from freezing.
 - 8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.
 - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.

- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
 - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

- C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

PART 2 PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected," Engineer will make selection.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 017300

EXECUTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field surveying.
 - 3. Installation of the Work.
 - 4. Cutting and patching.
 - 5. Coordination of Owner's portion of the Work.
 - 6. Coordination of Owner-installed products.
 - 7. Progress cleaning.
 - 8. Starting and adjusting.
 - 9. Protection of installed construction.
 - 10. Correction of the Work.

- B. Related Requirements:
 - 1. Section 01 10 00 - Summary of Work for limits on use of Project site.
 - 2. Section 01 33 00 - Submittal Procedures for submitting surveys.
 - 3. Section 01 77 00 - Closeout Procedures for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
 - 4. Section 02 41 10 - Selective Demolition for demolition and removal of selected elements within the building.

1.2 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.3 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

- B. Professional Engineer Qualifications: Refer to Section 01 40 00 - Quality Requirements.

- C. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner

- that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational Elements include, but are not limited to, the following:
 - a. Fire-suppression systems.
 - b. Plumbing piping systems.
 - c. Mechanical systems piping and ducts.
 - d. Control systems.
 - e. Communication systems.
 - f. Fire-detection and -alarm systems.
 - g. Electrical wiring systems.
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
 1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.
- C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer in accordance with requirements in Section 01 31 00 - Project Management and Coordination.

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Engineer promptly.

3.4 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Engineer. Maintain conditions required for product performance until Substantial Completion.

- D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Engineer. Fit exposed connections together to form hairline joints.

3.5 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 01 10 00 - Summary of Work.

- F. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 4. Proceed with patching after construction operations requiring cutting are complete.
- G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Engineer. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

- a. Use containers intended for holding waste materials of type to be stored.
- 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 50 00 - Temporary Facilities and Controls and and Section 01 74 10 - Construction Waste Management and Disposal.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 01 91 13 - General Commissioning Requirements.
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00

- Quality Requirements.

3.8 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

3.9 CORRECTION OF THE WORK

- A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION

SECTION 017419

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 1. Salvaging nonhazardous construction waste.
 2. Recycling nonhazardous construction waste.
 3. Disposing of nonhazardous construction waste.

1.2 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 RECYCLING DEMOLITION/CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.2 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.
 - 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 - 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

3.3 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.

END OF SECTION

SECTION 017700
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

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

1.2 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Engineer's use prior to Engineer's inspection, to determine if the Work is substantially complete.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest-control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services

- and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner's Contract Administrator. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner's Contract Administrator signature for receipt of submittals.
 5. Submit testing, adjusting, and balancing records.
 6. Submit sustainable design submittals not previously submitted.
 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Complete startup and testing of systems and equipment.
 3. Perform preventive maintenance on equipment used prior to Substantial Completion.
 4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
 5. Advise Owner of changeover in utility services.
 6. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 7. Terminate and remove temporary facilities from Project site, construction tools, and similar elements.
 8. Complete final cleaning requirements.
 9. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer and Owner's Contract Administrator will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit a final Application for Payment in accordance with Section 01 29 00 - Payment Procedures.

2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
 5. Submit Final Completion photographic documentation.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer and Contract Administrator will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
1. Submit on digital media acceptable to Engineer.
- D. Warranties in Paper Form:
1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- E. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - d. Remove labels that are not permanent.
 - e. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - f. Clean strainers.
- C. Construction Waste Disposal: Comply with waste-disposal requirements in Section 01 74 19 - Construction Waste Management and Disposal.

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations required by Section 01 73 00 - Execution before requesting inspection for determination of Substantial Completion.

END OF SECTION

SECTION 017823

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 1. Operation and maintenance documentation directory manuals.
 2. Systems and equipment operation manuals.
 3. Systems and equipment maintenance manuals.
 4. Product maintenance manuals.

1.2 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 1. Engineer will comment on whether content of operation and maintenance submittals is acceptable.
 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 1. Submit on digital media acceptable to Engineer. Enable reviewer comments on draft submittals.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Engineer will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer will return copy with comments.
 1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of comments and prior to commencing demonstration and training.
- E. Comply with Section 01 77 00 - Closeout Procedures for schedule for submitting operation and maintenance documentation.

1.4 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.5 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Construction Manager.
 - 7. Name and contact information for Engineer.
 - 8. Name and contact information for Commissioning Provider.
 - 9. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
 - 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.6 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
 - 1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 - 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 - 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.7 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
 - 1. Type of emergency.
 - 2. Emergency instructions.
 - 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 - 1. Gas leak.
 - 2. Water leak.
 - 3. Power failure.
 - 4. Water outage.
 - 5. System, subsystem, or equipment failure.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
 - 1. Instructions on stopping.
 - 2. Shutdown instructions for each type of emergency.
 - 3. Operating instructions for conditions outside normal operating limits.
 - 4. Required sequences for electric or electronic systems.
 - 5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Performance and design criteria if Contractor has delegated design responsibility.
 - 3. Operating standards.
 - 4. Operating procedures.
 - 5. Operating logs.
 - 6. Wiring diagrams.
 - 7. Control diagrams.
 - 8. Piped system diagrams.
 - 9. Precautions against improper use.
 - 10. License requirements including inspection and renewal dates.

- C. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated on Contract Documents.
 - 2. Manufacturer's name.
 - 3. Equipment identification with serial number of each component.
 - 4. Equipment function.
 - 5. Operating characteristics.
 - 6. Limiting conditions.
 - 7. Performance curves.
 - 8. Engineering data and tests.
 - 9. Complete nomenclature and number of replacement parts.

- D. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures.

- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

- F. Piped Systems: Diagram piping as installed and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.
- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 017839

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of Record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of pdf markups or scanned record prints.
 - 2) Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit PDF electronic files of pdf markups or scanned Record Prints.
 - 2) Include each drawing, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.

1.3 RECORD DRAWINGS

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

- g. Locations of concealed internal utilities.
 - h. Changes made by Supplemental Instruction, or Construction Change Directive.
 - i. Changes made following Engineer's written orders.
 - j. Details not on the original Contract Drawings.
 - k. Field records for variable and concealed conditions.
 - l. Record information on the Work that is shown only schematically.
3. Mark the Contract Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Use colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

1.4 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
 5. Note related Change Orders where applicable.
- B. Format: Submit record specifications as annotated PDF electronic file.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 017900

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
- B. Training of Owner's personnel in operation and maintenance procedures is required for the following:
 - 1. HVAC systems and equipment.
 - 2. Other components where required in individual specification sections.

1.2 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. The training schedule shall be subject to availability of Owner's personnel for training. Re-schedule sessions as required by the Owner. Once the training schedule has been approved by the Contract Administrator, failure by the Contractor to conduct sessions according to the approved schedule will be cause for Owner to charge Contractor for Owner's personnel training time.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

1.3 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23 - Operation and Maintenance Data.
- B. Set up instructional equipment at instruction location.

1.4 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner, through Contract Administrator, with at least ten days'

advance notice.

- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 DEMONSTRATION - GENERAL REQUIREMENTS

- A. Demonstrations provided during system start-up do not qualify as demonstrations as defined and described in this section, unless otherwise approved in advance by the Owner's Contract Administrator.
- B. Demonstrations provided during Functional Testing do not need to be repeated unless Owner personnel training is specified.
- C. Demonstration may be combined with Owner personnel training if applicable.
- D. Operation of Equipment and Systems:
 - 1. Demonstrate operation in all modes, including but not limited to:
 - a. Start-up.
 - b. Shut-down.
 - c. Seasonal mode changeover.
 - d. Emergency operation.
 - 2. Demonstrate troubleshooting and maintenance procedures.
 - 3. For equipment and systems that have different seasonal operation modes, provide demonstration for other season(s) within three months.

3.2 TRAINING - GENERAL REQUIREMENTS

- A. Provide training on-site unless otherwise indicated or approved.
- B. Owner will provide classroom and seating at no cost to Contractor.
- C. If Contractor's trainer(s) are not able to answer attendee questions raised during training session, provide written response within three days of the training session.

END OF SECTION

SECTION 019113

GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section describes work associated with commissioning of selected systems including commissioning meetings, construction checks, equipment start-up, functional testing, operations and maintenance manuals, and operator training.
- B. Work Provided Under Separate Contract: Owner's Commissioning Provider (CxP) will supervise commissioning activities and provide the following commissioning services:
 - 1. Develop commissioning plan.
 - 2. Assist Contractor to incorporate commissioning activities into Project Construction Schedule.
 - 3. Conduct commissioning meetings.
 - 4. Review project submittals.
 - 5. Develop Construction Checklists and Functional Test Plans.
 - 6. Observe Construction checks and start-up of selected equipment.
 - 7. Perform testing, adjusting, and balancing (TAB).
 - 8. Supervise and document functional testing.
 - 9. Review O&M manuals and as-built documents.
 - 10. Coordinate operator training.
 - 11. Prepare final commissioning report.
- C. Contractor shall provide the following services:
 - 1. Assign individuals representing Contractor and mechanical, electrical, controls, and low-voltage subcontractors as members of Commissioning Team.
 - 2. Incorporate commissioning activities in Contractor's construction schedule.
 - 3. Assist CxP in development of Construction Checklists.
 - 4. Execute Construction Checklists using Online Commissioning System.
 - 5. Perform Equipment Start-up.
 - 6. Perform contractor-directed verification of automatic controls, communications, and fire and life safety systems and provide required verification documentation.
 - 7. Assist CxP in development of Functional Test Plans.
 - 8. Assist CxP with Functional Testing.
 - 9. Assist CxP with Monitoring Based Commissioning activities described in Monitoring Based Commissioning Plan.
 - 10. Provide Operations and Maintenance documentation.
 - 11. Perform operator training and supervise training performed by manufacturer's representative.
 - 12. Provide submittals, product data, shop drawings, controls sequences, points list, wiring diagrams, schematics, and design documents to comply with LEED requirements and to assist in commissioning documentation development.
- D. Contractor shall provide related services as directed, including, but not limited to:
 - 1. Access to the Work
 - 2. Incidental labor, facilities, and equipment to assist CxP in conducting commissioning activities.
 - 3. Completion of required submittals.

4. Coordination of Work with activities of CxP.

1.2 RELATED SECTIONS

- A. 23 05 93 – Testing, Adjusting, and Balancing of HVAC Systems
- B. 23 08 00 – Commissioning of HVAC

1.3 DEFINITIONS

- A. CxP: Commissioning Provider (CxP) is the Individual responsible for supervising commissioning work.
- B. Construction Phase Commissioning Plan: Document prepared by the CxP that guides commissioning work through construction, verification, and warranty periods. The plan will include a listing of commissioning team members, systems to be commissioned, narrative description of the commissioning tasks and responsibilities, and a draft copy of the commissioning forms to be executed by the Contractor.
- C. Construction Phase: Phase of the project during which the facility is constructed and equipment is installed and started. During the Construction Phase, the Contractor completes construction checklists, performs equipment start-up, performs TAB work, submits O&M manuals, and performs control system verification. The Construction Phase generally ends at Substantial Completion.
- D. Verification Phase: Phase of the project during which functional testing and operator training is performed. The Verification Phase generally begins at Substantial Completion and ends at Final Completion.

1.4 SUBMITTALS

- A. Designated Commissioning Team Representatives: Submit list of names and contact information for individuals representing Contractor and Subcontractor as members of Commissioning Team.
- B. Construction Schedule: Submit updated project construction schedule to CxP monthly. Incorporate time and duration of Commissioning activities, as provided by CxP, into the construction schedule
- C. Construction Submittals and Shop Drawings: Provide as required to perform commissioning work.
 - 1. Contractor to provide CxP a copy of the submittal log. CxP will review the log and identify submittals that are associated with equipment and systems being commissioned and required to be submitted to the CxP.
 - 2. Contractor to provide an electronic copy of each submittal or shop drawing to the Owner's Representative, including all resubmissions, required by the CxP at the same time submittals are provided to the Design Team. CxP will review submittals concurrently with the Design Team and provide review comments to the Design Team. The Design Team will consolidate review comments into a single submittal review response to be provided to the Contractor.
 - 3. Contractor to provide a copy of Design Team submittal review comments to the CxP.
- D. Engineering Data: Provide shop drawings, product data, performance data, engineering data, installation and start-up data, operation and maintenance information, schematics,

wiring diagrams, programming manuals, and similar information as necessary for completion of the Work of the Section in accordance with Commissioning Schedule.

- E. Construction Checklists: Complete and submit to CxP for certification. Attach copies of all manufacturers' field or factory performance and start-up test documentation provided for associated equipment or systems.
- F. Control Verification Reports: The Contractor shall provide complete Control Verification Reports to the CxP.
 - 1. Complete reports developed by CxP and submit to CxP for certification.
 - 2. Contractor to provide the CxP with sample point-to-point verification forms that the Contractor will use during initial start-up and verification of systems. The CxP will review the forms and provide comments as necessary to the Contractor.
- G. Operator Training Schedule: Contractor shall submit training schedule listing all required training sessions as specified and in accordance with Training Plans. Training schedule shall include date and time of training, location, and name and qualification of trainer, and facilities needed for training. Training Schedule to be submitted to Owner's Authorized Representative four weeks prior to substantial completion.
- H. Operations and Maintenance Manuals: Furnish a copy of draft and final Operations and Maintenance Manuals for review by CxP. CxP will provide review comments to the Commissioning Team upon completion of CxP review.

1.5 QUALITY ASSURANCE

- A. Provide qualified mechanics and technicians to provide required commissioning services. Technicians shall have knowledge of the Work and experience with installation and operation of the general systems and components involved to assist in commissioning activities. Individuals shall be adequately equipped to effectively assist the CxP as necessary. Upon request, submit names and qualifications of technicians to CxP for approval.
- B. Provide qualified instructors to perform operator training. Instructor shall be knowledgeable in the specific equipment and systems involved. Upon request submit names and qualifications of technicians to CxP for approval.

1.6 SEQUENCING

- A. Schedule adequate time as determined by CxP for execution of Commissioning Plan.
- B. CxP will conduct a Commissioning Process Meeting approximately 30 days after Contractor received Notice-to-Proceed and after all subcontractors are identified.
- C. CxP will prepare a Construction Phase Commissioning Plan approximately 30 days after Commissioning Process Meeting.
- D. Provide construction submittals and shop drawings to CxP as described above in SUBMITTALS.
- E. Provide engineering data as required by CxP to prepare Construction Checklists within four weeks after date of approved submittal.

- F. CxP will conduct an initial commissioning coordination meeting approximately 30 days before equipment begins to arrive at the project site to coordinate commissioning activities and execution of construction checklists. Additional commissioning coordination meetings will be scheduled as necessary throughout the process to discuss commissioning schedule and coordination among trades.
- G. Perform Construction Checks as equipment is received, installed, and placed in operation. Construction checks shall be performed as work is completed. For example, equipment inspection shall be performed upon receipt of equipment on site, installation inspection shall be performed when equipment is set in place and anchored, and so on.
- H. Submit schedule for operator training to Owner's Authorized Representative and CxP four weeks prior to Substantial Completion. Schedule shall include time and duration of each required training session.
- I. Submit control verification reports three weeks after Substantial Completion.
- J. Functional testing will be scheduled after construction checklists; preliminary testing, adjusting, and balancing report; and control verification reports have been submitted and accepted. Contractor shall provide written notice that systems are completely operational and ready for functional testing. Functional testing may proceed prior to acceptance if the CxP and Owner's Authorized Representative determines that deficiencies will not significantly affect system performance and timing is critical. The CxP will provide notification of testing dates to Contractor, Architect, and Owner's Authorized Representative a minimum of one week prior to performing functional testing. Functional performance testing shall be completed and documented to obtain the certificate of occupancy by the authority having jurisdiction (AHJ). Functional performance testing that cannot be completed due to seasonal conditions shall be functionally tested when allowed by the post-occupancy operating conditions as determined by the CxP. Contractor to provide labor during the seasonal functional performance testing.
- K. Submit draft operations and maintenance manuals to Owner's Authorized Representative 30 days prior to substantial completion.
- L. Operator training shall be performed within a 30-day period following Substantial Completion. Training shall be executed by Contractor in accordance with manufacturer's requirements and training plans provided by CxP.
- M. Troubleshooting, corrections, and retesting shall be completed within three months of Substantial Completion.

1.7 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of a system or systems specified for this project is part of the construction process. Documentation and testing of these systems, as well as training of the operation and maintenance personnel, is required in cooperation with the CxP.
- B. The following systems will be commissioned as part of this project:
 - 1. Heating, ventilation and air-conditioning systems
 - a. Energy recovery units
 - b. Makeup air units
 - c. Water source heat pumps
 - d. Exhaust fans
 - e. Cooling towers and associated pumping

- f. Hydronic boilers and associated pumping
- g. Building automation control system
- h. Variable frequency drives

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide specialized test equipment including manufacturer's proprietary test equipment, as necessary for commissioning of mechanical and components. Comply with requirements of individual technical Sections of Division 23. Common test equipment such as temperature, pressure, speed, and electrical power measuring devices shall be provided by CxP.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Commissioning Meetings: Commissioning Team shall attend meetings as required by CxP including Commissioning Process Meeting, submittal review meetings, and coordination meetings prior to construction checks; adjusting and balancing; and functional testing. Commissioning team shall attend troubleshooting meetings as required to resolve issues identified in submittal reviews and commissioning reports.
- B. Construction Checklists:
 - 1. Provide equipment installation, start-up, and operating information requested by the CxP as required to develop Construction checklists.
 - 2. Perform construction checks for all equipment being commissioned as described in Construction Checklists prior to equipment start-up. The Contractor shall designate responsibility for completing construction checks among subcontractors. The designated subcontractor shall execute the checklists on the Online Commissioning System. The Contractor shall complete and submit executed forms to CxP for certification via the Online Commissioning System. All items listed in the Construction Checklists shall be complete prior to certification unless the incomplete item does not affect safe and reliable equipment operation. If such an item is identified, a description of the incomplete work must be submitted to the CxP via the Online Commissioning System. Equipment requiring construction checkout shall not be started until the Construction Checklists are fully executed by the Contractor.
 - 3. Contractor shall maintain "Cx Submittal Status Report." CxP will furnish Excel status report spreadsheet that will be used to monitor completion of construction checklists.
 - 4. Contractor shall startup equipment as described in construction checklists. Where required, provide manufacturer's agent to perform start-up as specified in Division 23..
 - 5. Fully executed Construction Checklists shall be submitted via the Online Commissioning System to the CxP for certification.
 - 6. CxP will document unresolved issues in a project Issues Log. The Issues Log documents status, responsibility, and required action for each unresolved issue.
 - 7. CxP shall perform a recheck of selected equipment. If minor discrepancies are identified, Contractor shall recheck all similar systems and resubmit Construction Check forms for certification. If major discrepancies are identified, CxP shall perform Construction Checks, and Contractor shall compensate Owner for additional commissioning costs by Contract modification.

- C. Control Verification Reports:
 - 1. Perform control system verification and prepare verification reports as specified in Division 23. Verification shall be performed by manufacturer's authorized installation contractor. Verification report shall include a description of the incomplete work.
 - 2. Submit completed Control Verification Reports to the CxP for acceptance.
 - 3. CxP will document unresolved issues in a project Issues Log. The Issues Log documents status, responsibility, and required action for each unresolved issue.

- D. Functional Tests:
 - 1. Assist CxP in performing Functional Tests, which shall generally include operating equipment and systems as necessary for testing. The CxP will record test measurements and documentation of results.
 - 2. CxP will document all unresolved issues in a project Issues Log. The Issues Log documents status, responsibility, and required action for each unresolved issue.
 - 3. CxP shall retest selected systems once to verify that corrective work is complete. Retests will be performed after notification from the Contractor that work is complete. If corrective work is not complete and additional retesting is required, Contractor shall compensate Owner for costs of additional CxP testing sessions by Contract modification.
 - 4. Assist the CxP with seasonal performance testing. Assistance includes access to the building automation control system, establishing and downloading trend data, and correcting identified deficiencies during seasonal testing.

- E. Issues Resolution: Unresolved issues will be listed in the project online Issues Log. Refer to Online Commissioning System in Article 1.03, Definitions above. Each issue will be identified with an identification number. The Issues Log will include a description of the unresolved condition, identify the responsible individual(s), and describe suggested corrective action. The Contractor will periodically access the On-line Commissioning System to monitor the status of commissioning issues, and shall diligently complete all tasks that are identified as the responsibility of the Contractor. The Contractor shall modify on-line issue status when each item is completed and provide a description of corrective action performed. Contractor and related subcontractors shall attend commissioning meetings to review the Issues Log and coordinate resolution of issues as required by the CxP.

3.2 QUALITY CONTROL

- A. Provide mechanics that are experienced with the Work and installed components of each system to assist in completion of the commissioning activities.
 - 1. Work necessary to provide systems complying with performance requirements of the contracts is the Contractor's responsibility.

- B. Manufacturer's Field Services: Provide manufacturer's representatives with expertise in components and systems. Where required, manufacturer's representative shall perform start-up, testing, and maintenance training of Owner's facilities staff including classroom and onsite instruction.

3.3 ACCESS TO WORK

- A. Contractor shall provide facilities and access for CxP to perform work including but not limited to:
 - 1. Keys, security passes, passwords, codes, etc.
 - 2. Ladders.

3. Lifts where work is more than 12 feet above floor level. The CxP shall have a lift certification; however, the Contractor shall also provide a lift operator for duration of commissioning when required for CxP site inspections and functional testing.
4. Removal of ceiling tiles, partitions, panels, or other fixed construction necessary for completion of work.
5. Proprietary programming and metering equipment.

END OF SECTION

SECTION 024110
SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of building systems and equipment.
 - 2. Demolition and removal of selected site elements.
 - 3. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
 - 2. Section 01 73 00 "Execution" for cutting and patching procedures.

1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.4 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.5 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.6 FIELD CONDITIONS

- A. Retain, revise, or delete this article to suit Project. Insert other limitations if necessary, such as when adjacent floors will be occupied.
- B. Owner will occupy the building immediately adjacent to selective demolition areas. Conduct selective demolition so Owner's operations will not be disrupted.
- C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Asbestos and other Hazardous Materials:
 - 1. It is not expected that hazardous materials will be encountered in the Work.

2. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

1.7 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

3.2 PREPARATION

- A. Refrigerant: In course of demolition, remove refrigerant containing mechanical equipment and ensure that refrigerant is recycled according to 40 CFR 82 and regulations of authorities having jurisdiction. Refrigerant containing mechanical equipment includes, but is not limited to water-source heat pumps.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed: Locate, identify, disconnect, and seal or cap off utility services and mechanical equipment and systems serving areas to be selectively demolished.
 1. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 2. Disconnect, demolish, and remove HVAC system equipment and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - e. Ducts to Be Removed: Remove portion of ducts indicated to be removed and

- plug remaining ducts with same or compatible ductwork material.
- f. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.
- g. Perform only that demolition work necessary and required for completion of new work.
- 3. In addition to demolition shown, cut, move or remove items as necessary to provide access, to allow alterations and new work to proceed, or items that abandoned and serve no useful purpose. Include such items as:
 - a. Repair or removal of hazardous or unsanitary conditions.
 - b. Removal of unsuitable or extraneous materials not marked for salvage, and debris such as rotted wood, rusted metals, and deteriorated concrete.
 - c. Removal of abandoned items and items serving no useful purpose as a result of the work of this contract such as abandoned piping, conduit and wiring. Remove items back to active piping mains or junction boxes.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- B. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
- B. Do not close isolation valves or shut down pumps without prior approval from Owner. Coordinate with the Owner's representative responsible for the area or equipment affected for any system interruptions which affect the operation of the remaining portions of the facility.
- C. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At

concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

5. Maintain fire watch during and for at least 1 hour after flame-cutting operations.
 6. Maintain adequate ventilation when using cutting torches.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- D. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- E. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area on Campus as designated by Construction managers.
 5. Protect items from damage during transport and storage.
- F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Insert other specific disposal, cleanup, or removal requirements to suit Project.
- B. Remove demolition waste materials from Project site and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."
1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 3. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- C. Burning: Do not burn demolished materials.

3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION

SECTION 075000

ROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Modification of existing roof system.

1.2 SUBMITTALS

- A. Submit the following product information, shop drawings, and certifications in accordance with Section 01 33 00.
 1. Roofing manufacturer's applicable installation specifications and details.
 2. List of materials proposed for use.
 3. Certification that roofing contractor is authorized by roofing manufacturer to perform work as required to maintain existing warranty.

1.3 QUALITY ASSURANCE

- A. Roofing contractor must be authorized by roofing manufacturer.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver material in original packages, manufacturer's original labels thereon. Do not remove labels or open packages until inspected by Owner's Authorized Representative.
- B. Deliver materials to jobsite on pallets. Pallet label shall indicate material name, production date and/or product code.
- C. Store bulk asphalt in heated tanker not greater than 350 degrees F. Avoid modification of asphalt physical properties resulting from long periods of overheating. Any heated tank shall not be left unattended at any time.
- D. Store materials in dry, protected areas in an upright position. Control temperature of storage areas in accordance with manufacturer's instructions. Protect materials from freezing.

1.5 ENVIRONMENT REQUIREMENTS

- A. Do not apply roofing unless correct system application temperatures can be maintained to obtain effective adhesion. Operation shall not be conducted when water in any form is present on deck, such as rain, dew, ice, frost, or snow.

1.6 WARRANTY

- A. Existing roofing system is under warranty. Roofing Contractor shall modify roofing to perform Work of this agreement in conformance with all the manufacturer's warranty requirements to maintain the existing warranty in full effect. The Roofing Contractor shall be responsible for proper placement of metalwork which has been provided by other trades and is in contact with roofing.
- B. Contractor shall provide a written labor and material warranty guaranteeing all modifications to the roofing and flashing systems performed as a part of this project's Work shall be weathertight for a period of two (2) years following final acceptance of the project.

PART 2 PRODUCTS

2.1 ROOFING SYSTEMS

- A. The existing roofing system is a Carlisle TPO roof system installed over roof insulation. All modifications shall be compatible systems by the original roofing system manufacturer and shall be visually compatible with the existing roof system color.
- B. Equipment curbs.
 - 1. Install new membrane to full height of curb and 10-12" past seem. Add outside reinforcement at all corners. Match existing membrane thickness.

2.2 FLASHING SYSTEMS

- A. Flashing system for modifications shall be approved by roofing manufacturer.

2.3 OTHER MATERIALS

- A. Manufactured or recommended by firm listed above and recommended by manufacturer for conditions of installation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Contractor and Owner shall perform a joint inspection of existing roof conditions prior to start of construction. Contractor shall photo document existing roofing defects and submit documentation to Owner's Authorized Representative. Beginning of work shall constitute acceptance of existing roof conditions.
- B. Do not proceed until surfaces to receive roofing are smooth, sound, clean, dry and free of defects. Do not start Work until conditions are satisfactory.
- C. Roof deck must be structurally sound. Areas showing a loss of integrity due to corrosion, rotting, warping, etc., shall be repaired or replaced prior to the installation of the roofing system.

3.2 PREPARATION

- A. Remove trash, debris, grease, oil, water, moisture, and contaminants which may affect

bond of asphalt deck surface.

- B. Prepare surfaces according to manufacturer's published instructions.
- C. Use cleaning materials necessary to render an acceptable surface.
- D. Use compatible materials on voids and joints so finished deck surface will be uniform.
- E. Incomplete membrane edges and flashings shall be protected against water entry so that they will remain watertight for an extended period if inclement weather occurs.
- F. Damage components must be repaired or replaced if building damage occurs during construction.

3.3 PROTECTION

- A. Protect against damage and discoloration caused by Work of this section. Prevent debris from entering and clogging roof drains and gutters.
- B. Protect existing roof membrane during construction from damage resulting from construction activities of all trades. Protect adjacent areas from damage with tarpaulin or other durable material.
- C. Protection shall be utilized at all hoisting points to protect building walls.

3.4 INSTALLATION

- A. Comply with all of the manufacturer's installation recommendations. Pay particular attention to any recommendations relating to patching of aged roofing systems.
- B. Plans and specifications show minimum requirements. Work shall conform to manufacturer's recommendations and installation instructions. Notify Owner's Authorized Representative if conflict exists between Construction Documents and manufacturer's instructions.

3.5 CLEANING

- A. Include Work of other sections, clean, repair and touch-up, or replace where directed, products which have been soiled, discolored, or damaged by Work of this section. Remove debris from project site at Work completion or sooner, if directed.

END OF SECTION

SECTION 230500

GENERAL HVAC PROVISIONS

PART 1 GENERAL

1.1 CONTRACT DOCUMENTS

- A. General HVAC provisions apply to all work performed in Division 23.
- B. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.
- C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.
- D. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Engineer and Owner's Authorized Representative prior to fabrication.
- E. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.
- F. For products specified by listing one or more manufacturers, followed by "Similar to" and one manufacture's model number, the following requirements apply:
 - 1. Approval of each listed manufacturer is contingent upon that manufacturer having a product which meets the specification, fits in the available space, and is comparable to the listed model.
 - 2. Electrical requirements, duct requirements, pipe connections, and space requirements indicated on drawings are based on the listed model and may not be suitable for all manufacturers listed. Provide revisions required to accommodate the model actually furnished.
- G. For product specified by listing one or more manufacturers, followed by a model number for each manufacturer, the following requirements apply:
 - 1. Provide one of the listed model numbers or an approved substitution.
 - 2. Electrical requirements, duct connections, pipe connections, and space requirements indicated on the Drawings are based on one of the listed models and may not be suitable for all models listed. Provide revisions required to accommodate the model actually furnished.

1.2 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): A federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority.
- B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

- C. The words furnish, install and provide are defined as follows:
 - 1. Furnish: To supply and deliver to the project ready for installation and in operable condition.
 - 2. Install: To place in final position, complete, anchored, connected in operable condition.
 - 3. Provide: To furnish and install complete. Includes the supply of specified services.
 - 4. When neither furnish, install or provide is stated, provided is implied.
- D. Where content in other sections or divisions is referenced, the words refer and conform are defined as follows:
 - 1. Refer (To): The work referenced in the identified section or division is provided under the referenced section or division. The referenced work is listed for clarity and coordination.
 - 2. Conform (To or With): The work is provided under the section containing the reference and must comply with the requirements of the referenced section or division.

1.3 COORDINATION

- A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Engineer and secure written approval and agreement on necessary adjustments before start of work.
- B. Coordinate identification systems with other trades. All mechanical systems shall use identical piping, valve, and equipment identification and regulatory signage.

1.4 SUBMITTALS AND SHOP DRAWINGS

- A. See Division 01.
- B. Action Submittal Content.
 - 1. Action submittal information not expressly required by the specifications will not be reviewed.
 - 2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
 - 3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
 - 4. Action submittal requirements are listed in individual specification sections. The following definitions apply.
 - a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
 - b. Catalog data: Manufacturer's standard product cut sheet.
 - c. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.
 - d. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.
 - e. Wiring Diagrams: Power and control wiring diagrams.

- f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.
- g. Installation Instructions.
- h. Special Requirements Listed: Additional requirements indicated in individual specification sections.

1.5 QUALITY ASSURANCE

- A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.
- B. Asbestos products or equipment or materials containing asbestos shall not be used.
- C. Certify that each welder has passed the American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

1.6 DESIGN REQUIREMENTS

- A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.
- B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.
- C. Delegated Design.
 - 1. Conform to Section 014000 "Quality Requirements."
 - 2. The Contractor shall provide delegated design services where indicated in the Contract Documents and obtain necessary approval from the AHJ. The Contractor shall be responsible for the design, calculations, submittals, permits, fabrication, transportation and installation of these Delegated Design components. The Contractor is responsible to submit all Delegated Design documents required for approvals by regulatory agencies for each item of delegated design work.
 - 3. Delegated design work shall be performed by a properly licensed design professional registered in the State in which the work is performed where required by the AHJ or as specified herein.
 - 4. Comply with requirements of the AHJ over the Work current at the time of submission. The Contractor is responsible to coordinate and submit all material required by the AHJ so review and process of submittals and permits will not adversely affect the construction schedule. Each Delegated Design item requiring review by the AHJ must be provided by the Contractor and all fees and costs associated therewith shall be the Contractor's responsibility at no additional cost to the Owner.
 - 5. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.
 - 6. Delegated-Design Services Certification: In addition to shop drawings, product data, and other required submittals, submit digitally signed PDF electronic file, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - a. Indicate that products and systems comply with performance and design criteria

in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.7 CODES AND STANDARDS

- A. The Work shall conform to the following Codes and Standards.
 - 1. Codes and Regulations of Governing Authority.
 - 2. Americans with Disabilities Act (ADA).
 - 3. Owner's Construction Standards or Guidelines.
- B. Contract Documents are intended to comply with referenced Codes and Standards. Any deviation from applicable codes and standards identified in Contract Documents shall be submitted in writing to the Engineer.
- C. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.
- D. Contractor shall comply with Governing Authority for the disposal of hazardous materials including used refrigerant. Provide documentation to the Owner's Authorized Representative certifying that hazardous materials were properly disposed of.

1.8 SEQUENCING

- A. Testing, adjusting, and balancing of HVAC systems will begin after commissioning construction checks and equipment start-up are complete and Systems Ready to Balance Checklist forms have been executed and submitted.
- B. Submit schedule for operator training eight weeks prior to Substantial Completion. Schedule shall include time and duration of each required training session.
- C. Submit draft operations and maintenance manuals to Owner's Authorized Representative 30 days prior to substantial completion.
- D. Operator training shall be performed prior to Substantial Completion, or as otherwise approved by the Owner's Authorized Representative.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean and dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
- E. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
- F. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

- G. Replace installed products damaged during construction.

1.10 TEMPORARY SERVICES

- A. Provide in accordance with Division 01 as required for completion of work.
- B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.
- C. All mechanical systems currently operating including HVAC equipment and controls, which serve Owner occupied areas, must be maintained operational during construction. It is the responsibility of the Contractor to provide temporary facilities as required to maintain operation. If any system currently in use must be turned off to perform work, permission must be obtained, and owner notified prior to performing any work.

1.11 OPERATIONS AND MAINTENANCE MANUALS

- A. Furnish operation and maintenance data for project, as described herein.
- B. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF files.
 - 1. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each.
 - 2. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 3. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.
 - 4. Manual Content: Manuals shall contain complete information for each item of mechanical, electrical or other operating equipment. Include as applicable:
 - a. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance.
 - b. Lubrication schedules.
 - c. Performance capacity.
 - d. Final approved product submittals for each product included in project.
 - 1) Mark the model actually provided where the literature covers more than one model. Include all submittal data corrected to "as-built" conditions within the manual.
 - 2) Parts list.
 - e. Maintenance schedules.
 - 5. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.
 - 6. Reports: Copy of any specified testing or quality control reports.
 - 7. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.12 RECORD DRAWINGS

- A. Provide record "as-built" drawings in accordance with Division 01 requirements. Show all deviations from contract drawings and location of underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Alternately, provide electronically using .pdf markup of contract drawings.

PART 2 PRODUCTS

2.1 PRODUCTS AND MATERIALS

- A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.
- B. Materials and equipment used as the basis of design is scheduled on Drawings or designated in product specifications. If Contractor chooses to use products that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated mechanical and electrical systems needed to provide equal system performance and maintainability.

2.2 ELECTRICAL EQUIPMENT

- A. Electrical Disconnect Switch: Electrical disconnect switches specified for mechanical equipment shall conform to OSHA Lock-out/Tag-out requirements.
- B. All electrical equipment shall be listed as approved for its application by the Underwriters Laboratory or other testing agency approved by the State of Oregon Electrical and Elevator Board. Approval indicates agency meets testing standard requirements for electrical safety required by Oregon Revised Statutes 479.510 through 479.855 and Oregon Administrative Rules.
- C. Enclosure: Provide the following electrical equipment enclosure types unless specifically stated otherwise in individual specification sections.
 - 1. NEMA 1: Dry, enclosed locations where the ambient temperature will not be outside of the VFD temperature ratings.
 - 2. NEMA 12: Enclosed mechanical spaces equipped with floor drains where dripping or splashing may occur and where the ambient temperature will not be outside of the VFD temperature ratings.
 - 3. NEMA 3R: Outdoors spaces exposed to weather and where NEMA 4 or 4X is not required.
 - 4. NEMA 4: Mechanical spaces where hose directed-water is expected.
 - 5. Outdoor Enclosures with Temperature Control: NEMA 3R. Provided with a ventilation fan and heater capable of maintaining enclosure temperature within the manufacturer's recommended range. Drive and enclosure shall be a single, UL-listed assembly with single point electrical connections.

2.3 FIRESTOPPING

- A. Acceptable Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. 3M.
 - 2. Hilti.
 - 3. Nelson Firestop Products.
 - 4. Tremco.
- B. Provide firestopping for the following:
 - 1. All penetrations through fire resistance rated floors, walls and partitions including openings containing pipes, ducts and other penetrating items.
 - 2. All penetrations through non-fire resistance rated floors where the vertical service riser penetrates three or more floors.
- C. Firestop system shall be UL Classified for the application and correspond to those indicated by reference to designation listed by UL Fire Resistance Directory.
- D. Material shall be tested in accordance with UL-1479, ASTM E-814 for the specific fire-rated construction conditions confirming to construction assembly type, penetration item type, annular space requirements, and fire-rating involved.

2.4 BELT DRIVES FOR HVAC EQUIPMENT

- A. Provide belts, sheaves, and belt guards for a belt driven equipment.
- B. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning. Drive selection as follows, except where otherwise specified:
 - 1. Standard Equipment: One or more belts with 1.35 service factor based on fan motor.
 - 2. Critical Equipment: Two or more belts with 2.5 service factor based on fan motor shall be provided for equipment that is served by a standby power system or provides an emergency or life-safety function.
- C. Sheaves: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
- D. Motor Sheave: Adjustable pitch for use with 7.5-hp motors and smaller; fixed pitch for use with motors larger than 7.5 hp. Select sheave size so pitch adjustment is at the middle of adjustment range at fan design conditions.
- E. Belts: Oil resistant, non-sparking, and non-static; in matched sets for multiple-belt drives.
- F. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated. Make provision for motor and fan rpm measurement without removing the guard.

2.5 ROOF CURBS, BASES, AND RAILS

- A. Acceptable Manufacturer: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Greenheck Fan Corporation.
 - 2. RPS by Duravent.

3. The Pate Company.
 4. Thybar.Corporation.
- B. Roof Equipment Curbs, Bases and Rails Without Integral Vibration Isolation: Provided by supplier of associated equipment and conform to the following requirements and to requirements shown on Drawings:
1. General:
 - a. Submittals: Provide curb, base, and rail submittals as part of associated rooftop equipment submittal packages.
 - b. Seismic and Wind Load: Design curbs, bases, and rails to withstand seismic and wind load forces on equipment in accordance with performance requirements listed in Division 23. Provide attachments including:
 - 1) Equipment to curb.
 - 2) Curb to building structure.
 - c. Provide design calculations verifying that seismic and wind load restraint will comply with the Oregon Structural Specialty Code for the site and the building type listed where required. Drawings, details, and calculations related to seismic and wind load design shall be signed and sealed by an engineer specializing in the associated work and registered in State of the project site.
 2. Coordination: Coordinate configuration and height of curb with roofing contractor.
 - a. Provide sloped curbs to match roof conditions.
 - b. Curbs shall be provided with cants compatible with roofing system and roofing insulation thickness in accordance with roofing manufacturer's recommendations.
 - c. Provide wood nailers where required.
 - d. Provide 16-inch curbs, except as otherwise specified or shown on Drawings. Adjust curb height for roof insulation thickness. Exposed curb height above insulation shall be not less than twelve inches.
 3. Equipment Curbs.
 - a. Base: Constructed of G90 galvanized steel framing. Design internal framing to accommodate ductwork, air plenums, piping and conduit as shown on Drawings. Components shall be non-combustible.
 - b. Damper Tray: Provided by curb manufacturer where required.
 - c. Insulation: Factory or field applied closed-cell insulation with a minimum R-value of R-10.
 - d. Furnish curb with integral crickets if required by roof installation.

PART 3 EXECUTION

3.1 ACCESS TO EQUIPMENT AND ACCESSORIES

- A. Install equipment with sufficient access for service. Where not conveniently accessible by other means, provide adequately sized access doors for valves, dampers, motors, belts, and all other mechanical equipment requiring access for removal or maintenance. Type, size and exact location of access doors shall be coordinated with Engineer prior to work.
- B. Provide clearances for maintenance access as indicated on Drawings or as recommended by manufacturer. If access requirements shown on Drawings conflict with manufacturer's recommendations, provide larger clearance of the two.
- C. If equipment location shown on Drawings does not allow required access, notify Engineer prior to start of work.
- D. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to Engineer for resolution prior to starting work.

- E. Provide access doors as required for access to mechanical equipment. Doors required for access are not necessarily shown on Drawings. Consult with Engineer for direction on placement of required doors not shown on Drawings.
 1. Comply with manufacturer's instructions for installation of access doors. Provide all necessary support and supplemental framing for assembly where the access doors are required. Set accurately in position, plumb, level, and flush to adjacent finish surfaces; and secure to support.
- F. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
- G. Comply with OSHA regulations.
- H. Inaccessible Equipment.
 1. Where the Owner's Authorized Representative determines that the Contractor has installed equipment not accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
 2. The term "accessible" is defined as capable of being reached from floor level or from a ladder without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork to perform all necessary operation, maintenance, and replacement functions. The maximum distance of a maintainable component from an access point shall not exceed 20 inches.

3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, lights, electrical outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- C. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- D. Minor Piping: Small diameter pipe runs from drips and drains, water cooling, and similar minor services are generally not shown but must be provided. Contractor is responsible to provide all such minor piping where needed to maintain mechanical spaces clean and dry and to allow full equipment function and maintenance.
- E. Interconnection of Controls and Instruments: Generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments, and computer workstations. Comply with NFPA-70.
- F. Switchgear Drip Protection: Do not install piping above electrical switchgear.

3.3 RIGGING

- A. Design is based on use of available structure without modification except as specifically shown. Existing openings in building structures are planned to accommodate design

scheme.

- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Engineer under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Where it is not clear that the building structure has adequate capacity to support rigging, Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to existing building structure, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- E. Restore building to original condition upon completion of rigging work.

3.4 EXISTING EQUIPMENT DEMOLITION, REUSED, OR RELOCATED

- A. Contractor shall remove existing materials, equipment, and systems specified, shown on drawings or as otherwise required to perform the Work.
- B. Decommission equipment to be removed or abandoned on site. Remove hazardous materials from equipment and prior to removal. Provide permanent weather resistant label identifying that hazardous material have been removed from unit.
- C. All equipment designated for reuse in place, relocated, or furnished by Owner for reuse shall be cleaned and repaired before reinstallation. Any items requiring repair shall be brought to the attention of the Owners Authorized Representative before the item is reinstalled. Damage not brought to the attention of the construction manager shall be deemed the result of reinstallation of the item and shall be repaired without expense to the Owner.

3.5 MECHANICAL SYSTEMS FIRESTOPPING

- A. Do not cover firestop installations until they are examined by the Authority Having Jurisdiction, if required.
- B. Install firestopping in accordance with manufacturer's recommendations and conditions of product UL listing.

3.6 ROOF CURBS,

- A. Curbs: Install roof curbs on roof structure, level and secure, according to details on Drawings. Install and secure equipment, and coordinate roof penetrations and flashing with roof construction.

3.7 LUBRICATION

- A. Lubricate all devices requiring lubrication prior to initial operation. Field check all devices for proper lubrication.
- B. Equip all devices with required lubrication fittings or devices.

- C. All lubrication points shall be accessible without disassembling equipment, except to remove access panels.

3.8 CLEANING SYSTEMS

- A. General: After all equipment, pipes and duct systems are installed, system shall be thoroughly cleaned. Remove all stickers and tags from equipment or fixtures. Clean all piping systems prior to installation of insulation or painting.
- B. Hydronic Piping: Clean and flush hydronic piping and strainers as required to complete work described in Section 232513 - Water Treatment for Hydronic Systems.
- C. Air Distribution Duct System:
 - 1. Remove all debris from system before operation. Under no circumstances shall system be operated without filters. Replace filters used during construction with new filters.
 - 2. Repair or replace any discolorations or damage to system, building finish, or furnishings resulting from Contractor's failure to properly clean system.

3.9 START UP

- A. The Mechanical Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.
- B. Start equipment in accordance with manufacturer's recommendations and under manufacturer's supervision where required. Ensure that associated filters, strainers, electrical overloads, and other devices intended to protect the equipment are installed and functional prior to startup.
- C. Verify that piping has been flushed and cleaned prior to startup.
- D. The Mechanical Contractor shall perform TAB system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. TAB system-readiness checklists will be provided by the TAB Specialist. See Section 230593 - Testing, Adjusting, and Balancing for HVAC.

3.10 DEMONSTRATION

- A. General: After installation is complete, demonstrate to Engineer and Owner's Authorized Representative satisfaction as being complete and operational and entirely in conformance with Contract Documents.
- B. Preparation: Prior to demonstration, submit check-off list indicating completeness of submittals and certificates of compliance for review to Owner's Authorized Representative. Operate completed system for one week. Verify that control verification is complete and verification report has been approved by Engineer.
- C. Arrange for demonstration with Owner's Authorized Representative, Engineer, required factory technicians, and installer at least one week in advance of demonstration.

3.11 TRAINING

- A. Instruct Owner in proper operation and maintenance of equipment and systems.

Instruction shall generally include topics listed in manufacturer's operations and maintenance manual. Operator instructions shall cover all aspects of manual, automatic, and safety controls. Contractor shall also instruct the Owner in the general configuration of systems and location of equipment and components.

- B. Furnish competent qualified technicians knowledgeable in the building HVAC systems and equipment provided for this project for a minimum of four hours on-site to instruct Owner in operation and maintenance of systems and equipment. This figure does not include additional training noted under individual specification sections. Contractor shall keep a log of this instruction including date, times, subjects, and those present and shall present such log when requested by Engineer. Contractor shall coordinate training with Owner's Project Manager and provide a schedule for training minimum two-weeks prior to Substantial Completion. All training shall be complete 30-days after Substantial Completion.
- C. Contractor shall furnish training by equipment manufacturers in addition to training described in this section where specifically listed in other sections. Contractor shall schedule training with Owner's Project Manager minimum 48-hours prior to training session. Equipment shall be fully operational prior to scheduling training session. Manufacturer's field start-up, adjustment, and service will not fulfill manufacturer's training requirement.
- D. Contractor shall coordinate operator training with the Owner's Authorized Representative as follows:
 - 1. Training Schedule: Contractor shall develop and submit a training schedule listing all required training including contractor training, manufacturer training, and factory training as specified for approval by the Owner's Authorized Representative.
 - 2. Training Record and Evaluation Section: Contractor shall maintain a Training Record documenting attendees and duration of each training session. The Contractor shall complete Training Record after each training session. Submit training record when all training is complete.

END OF SECTION

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, squirrel-cage induction and electrically commutated motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 1. Motor controllers.
 2. Torque, speed, and horsepower requirements of the load.
 3. Ratings and characteristics of supply circuit and required control sequence.
 4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40°C and at altitude of 3,300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE INDUCTION MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15 unless listed otherwise under section where motor is provided.
- D. Rotor: Random-wound, squirrel cage.
- E. Bearings: Re-greaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.

- F. Temperature Rise: Match insulation rating.
- G. Insulation: Class F.
- H. Code Letter Designation:
 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- J. Enclosure Type: Provide open drip proof enclosure, except provide totally enclosed fan cooled enclosure for the applications listed below, or as expressly specified elsewhere, or as indicated on Drawings.
 1. Outdoor applications including roof exhaust fans, cooling towers, and similar equipment.
 2. Fan motors mounted in an unfiltered air stream.
 3. Motors on equipment related to life safety including smoke exhaust fans, fire pumps and similar equipment.
 4. Motors 10 HP and larger.
- K. Additional Requirements for Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 1. Inverter Duty as defined in NEMA MG 1 with Class F temperature rise; Class H insulation.
 2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 3. Maximum RPM: 3600 rpm minimum, or 150% of as design motor speed, whichever is greater.
 4. Speed Ratio:
 - a. Constant load applications: 4:1, except 1000:1 where high turndown motor is required.
 - b. Variable torque applications: 20:1, except 1000:1 where high turndown motor is required.
 5. Bearing Protection Ring: For motors controlled by variable frequency drives, provide maintenance free, conductive microfiber, shaft grounding ring with a minimum of two rows of circumferential microfibers to discharge electrical shaft currents within the motor and/or its bearings. AEGIS SGR or approved equal.
- L. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.4 SINGLE-PHASE ELECTRICALLY COMMUTATED MOTORS

- A. General: Electrically commutated, variable-speed, DC, brushless, direct drive type. Motor rotor shall be permanent magnet type with near zero rotor losses.
- B. Bearings: Heavy duty, pre-lubricated, antifriction ball bearings.
- C. Motor Controller: Single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator. Motors designed for synchronous rotation and to overcome reverse rotation.
 1. Operating Speed: Controllable from 100% to 20% of full speed.
 2. Motor Control: Remote digital input.
 3. Speed Control: Provide either manual or remote speed control input as specified and

as required to perform intended function:

- a. Manual: Potentiometer dial mounted on the motor.
 - b. Remote modulating analog input: 4-20mA or 0-10 VDC.
4. Soft-start function to reduce inrush current at start-up.
 5. Overcurrent Protection.
 6. Thermal Overload Protection.
- D. Electrical Input: Single phase, 60 hertz. Voltage as required or as scheduled on drawings.
- E. Efficiency: Motor shall be minimum of 70% efficient over entire operating range.

2.5 SINGLE-PHASE INDUCTION MOTORS

- A. Motors larger than 1/20 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify motor mounts are compatible with motor frame.

3.2 INSTALLATION

- A. Motors Used with Variable Frequency Controllers: Arrange location of motor, variable frequency controller and electrical wiring to ensure the distance from motor to inverter does not exceed manufacturer recommended maximum length.

3.3 APPLICATION

- A. EC Motor Speed Control.
1. Remote speed control where required for variable volume applications to perform specified control sequences.
 2. Manual speed control for constant volume applications.
- B. Induction Motors.

1. Motors Less Than 1/2 HP: Single-Phase.
2. Motors 1/2 HP and larger: Polyphase.

END OF SECTION

SECTION 230514

COMMON MOTOR CONTROL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Motor controller use on ac power systems up to 600 V installed at equipment manufacturer's factory or furnished separately for field installation.
- B. Section Includes:
 - 1. Single Phase Motor Controllers.
 - 2. Full-voltage magnetic motor controllers.
 - 3. Combination full-voltage magnetic motor controllers.
 - 4. Variable frequency drive motor controllers.
 - 5. Enclosures.
 - 6. Accessories.

1.2 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. DDC: Direct digital control.
- E. EMI: Electromagnetic interference.
- F. OCPD: Overcurrent protective device.
- G. PID: Control action, proportional plus integral plus derivative.
- H. RFI: Radio-frequency interference.
- I. SCCR: Short-circuit current rating.
- J. SCPD: Short-circuit protective device.
- K. VFD: Variable-frequency drive motor controller.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of magnetic motor controller.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include control for VFDs.
 - a. Control and monitoring functions.
 - b. Hardwired input and output control capabilities.
 - c. Network communications capabilities.

- B. Shop Drawings: For each type of magnetic controller.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
 - 3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
 - 4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- C. Product Schedule: List the following for each controller:
 - 1. NRTL listing.
 - 2. Factory-installed accessories.
 - 3. SCCR of integrated unit.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for magnetic controllers, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Listing of network communication point data that shared with BAS.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.
 - 1. In addition to items specified in Division 01, include the following:
 - a. Routine maintenance requirements for magnetic controllers and installed components.
 - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - c. Manufacturer's written instructions for setting field-adjustable overload relays.
 - d. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.8 FIELD CONDITIONS

- A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.
 - 3. The effect of solar radiation is not significant.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. VFD controllers to comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.
- D. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.
- E. Overload Relay Trip Characteristics: Provide Class 20 except as follows:
 - 1. Motor controller that are integral with equipment assembly and installed at the manufacturer's factory shall have trip characteristics as recommended by the equipment manufacturer.
 - 2. Submersible Pumps: Class 10.
- F. Factory Assembled Equipment:
 - 1. Each motor controller shall be provided with a factory installed isolation switch.

2.2 SINGLE PHASE MOTOR CONTROLLERS

- A. Single Phase Motor Control Relay: Refer to 23 09 25 - BAS Field Mounted Devices for HVAC.

2.3 MAGNETIC MOTOR CONTROLLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company.
 - 3. Rockwell Automation, Inc.
 - 4. Siemens Industry, Inc.
 - 5. Schneider Electric, Square D.
- B. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Non-reversing.
- E. Contactor Coils: Pressure-encapsulated type.
 - 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
 - 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
- G. Overload Relays:
 - 1. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

2.4 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company.
 - 3. Rockwell Automation, Inc.
 - 4. Siemens Industry, Inc.
 - 5. Schneider Electric, Square D.
- B. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Non-reversing.

- E. Contactor Coils: Pressure-encapsulated type.
 - 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
 - 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
- G. Overload Relays:
 - 1. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
- H. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
- I. Fusible Disconnecting Means:
 - 1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
 - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- J. Non-fusible Disconnecting Means:
 - 1. NEMA KS 1, heavy-duty, horsepower-rated, non-fusible switch.
 - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- K. MCP Disconnecting Means:
 - 1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- L. MCCB Disconnecting Means:
 - 1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - 2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5 VARIABLE FREQUENCY DRIVE MOTOR CONTROLLER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Low Voltage HVAC Drives.
 - 2. Danfoss.
 - 3. Siemens Industry, Inc., Building Technologies Division.
 - 4. Square D; by Schneider Electric.

- B. Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 2. Listed and labeled for integrated short-circuit current rating by an NRTL acceptable to authorities having jurisdiction.
- C. Application: Variable torque.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
 3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
 4. Minimum Efficiency: 97 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
 7. Ambient Temperature Rating: Not less than 10 deg F and not exceeding 104 deg F.
 8. Humidity Rating: 5 to 95 percent (noncondensing).
 9. Altitude Rating: Not exceeding 3300 feet.
 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 13. Speed Regulation: Plus or minus 5 percent.
 14. Output Carrier Frequency: Selectable; 1.0 to 12 kHz.
 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.
- H. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 0.1 to 999.9 seconds.
 4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- I. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFD, complying with UL 1449 SPD, Type 1 or Type 2.
 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.

3. Under- and overvoltage trips.
 4. Inverter overcurrent trips.
 5. VFD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
 11. Motor-overtemperature fault.
- J. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- K. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- M. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFD input current rating.
 2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
 3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
- N. Controls and Indication.
1. Status Lights: Door-mounted LED indicators displaying the following conditions:
 - a. Power on.
 - b. Run.
 2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 - b. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - 1) Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.
 3. Historical Logging Information and Displays:
 - a. Real-time clock with current time and date.
 - b. Running log of total power versus time.
 - c. Total run time.
 - d. Fault log, maintaining last four faults with time and date stamp for each.
 4. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:
 - a. Output frequency (Hz).
 - b. Motor speed (rpm).

- c. Motor status (running, stop, fault).
 - d. Motor current (amperes).
 - e. Motor power (kW).
 - f. Motor torque (percent).
 - g. Fault or alarming status (code).
 - h. PID feedback signal (percent).
 - i. DC-link voltage (V dc).
 - j. Set point frequency (Hz).
 - k. Motor output voltage (V ac).
5. Control Signal Interfaces:
- a. Electric Input Signal Interface:
 - 1) A minimum of two programmable analog inputs.
 - 2) A minimum of six multifunction programmable digital inputs.
 - b. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems.
 - c. Output Signal Interface: A minimum of two programmable analog output signal(s), which can be configured for any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (V dc).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set point frequency (Hz).
 - d. Remote Indication Interface: A minimum of three programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - 1) Motor running.
 - 2) Set point speed reached.
 - 3) Fault and warning indication (overtemperature or overcurrent).
 - 4) PID high- or low-speed limits reached.
6. PID Control Interface: Provides closed loop setpoint, differential feedback control in response to dual feedback signals. Allows for closed loop control of fans and pumps for pressure, flow, or temperature regulation.
- a. Number of Loops: Two.
7. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFD settings shall be retained within VFD's nonvolatile memory. Third party gateways and multiplexers is not acceptable.
- a. Hardwired Points:
 - 1) Control: On-off operation.
 - 2) Monitoring: On-off status.
 - 3) Alarm Status.
 - 4) Motor Speed Feedback.
 - b. Communication Interface: Communication shall interface with DDC system for HVAC to remotely control and monitor VFD from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at VFD panel shall be available through the DDC system for HVAC. All protocols shall be "certified" by the governing authority (i.e., BTL Listing for BACnet). Use of non-certified protocols is not allowed.
 - 1) The VFD shall have an EIA-485 port and support the following communication protocols:
 - a) BACnet: The BACnet connection shall be an EIA-485 and comply with ASHRAE 135, MS/TP or or Ethernet and comply with ASHRAE 135, IP interface. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-

ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC.

- O. Line Conditioning and Filtering.
 - 1. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.
 - 2. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.6 ENCLOSURES

- A. Enclosures for field mounted and factory package equipment assemblies.
 - 1. Field Mounted: Comply with NEMA 250, type designations, complying with environmental conditions at installed location.
 - 2. Conform to 23 05 00 - General HVAC Provisions, Electrical Equipment.
 - 3. Factory Packaged Equipment Assemblies: Comply with 23 05 00 - General HVAC Provisions, Electrical Equipment and requirements of package equipment specifications sections.
- B. The construction of the enclosures shall comply with NEMA ICS 6.
- C. Controllers in hazardous (classified) locations shall comply with UL 1203.

2.7 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
- B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.
 - 1. Phase-failure.
 - 2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
 - 3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.
- C. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 3R, Type 4X, Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- D. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.
- F. Hand-Off-Auto Switch: Safety interlocks for life-safety or emergency shutdown to protect equipment or systems shall be wired so that safety interlocks are active in both Hand and Auto position.

3.3 APPLICATION

- A. Provide motor controllers as scheduled on drawings and as otherwise specified.
- B. Provide Single Phase Motor Control Relays for single phase motors less than ½ horsepower.
- C. Magnetic Motor Controllers.
 - 1. Field Installed: Combination Magnetic Motor Controllers.
 - 2. Factory Packaged Assemblies: Magnetic Motor Controllers or Combination Magnetic Motor Controllers. Comply with requirements of equipment specification sections.

3.4 FIELD QUALITY CONTROL

- A. Start-up and Testing of Motor Controllers other than VFDs.
 - 1. Contractor to test and inspect components, assemblies, and equipment installations, including connections.
 - 2. Tests and Inspections:
 - a. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
 - b. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, and grounding.
 - 4) Verify the unit is clean.
 - 5) Inspect contactors:
 - a) Verify mechanical operation.
 - b) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
 - 6) Verify overload element rating is correct for its application.
 - 7) Inspect bolted electrical connections for high resistance.
 - 8) Verify appropriate lubrication on moving current-carrying parts and on moving

- and sliding surfaces.
 - c. Electrical Tests:
 - 1) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1.
 - 2) Test motor protection devices according to manufacturer's published data.
 - 3) Test circuit breakers as follows:
 - a) Operate the circuit breaker to ensure smooth operation.
 - b) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
 - 4) Perform operational tests by initiating control devices.
 - d. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
 - 1) Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
 - 2) After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
 - 3) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.
 - 4) Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, test results, and indicate area of elevated temperature.
 - 5) Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 6) Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
- B. Start-up and Testing of VFDs.
1. Perform tests and inspections with the assistance of a factory-authorized service representative.
 2. Acceptance Testing Preparation:
 - a. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
 - b. Test continuity of each circuit.
 3. Tests and Inspections:
 - a. Inspect VFD, wiring, components, connections, and equipment installation.
 - b. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
 - c. Test continuity of each circuit.
 - d. Test each motor for proper phase rotation.
 - e. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - f. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - g. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
 - 1) Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFD. Remove front panels so joints and connections are accessible to portable scanner.
 - 2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of

- each VFD 11 months after date of Substantial Completion.
- 3) Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4) Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
- h. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Motor controller will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION

SECTION 230519

METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermometers, mounting brackets, and thermowells.
 - 2. Pressure gages and gage attachments.
 - 3. Test plugs.

1.2 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 230500 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
 - 1. Materials List.
 - 2. Catalog Data.
 - 3. Product Data.
 - 4. Performance Data.
 - 5. Wiring Diagrams.
 - 6. Shop Drawings.
 - 7. Installation Instructions.
 - 8. Special Requirement listed herein

PRODUCT TABLE	1	2	3	4	5	6	7	8
Thermometers, Thermowells, and Accessories		X						
Pressure Gauges and Gauge Attachments		X						

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 THERMOMETERS, THERMOWELLS, AND ACCESSORIES

- A. Bimetallic-Actuated Thermometers.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Marsh Bellofram.
 - c. Palmer Wahl Instrumentation Group.
 - d. Terice, H. O. Co.
 - e. Weiss Instruments, Inc.
 - 2. Standard: ASME B40.200.
 - 3. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

4. Dial: Non-reflective aluminum with permanently etched scale markings and scales in degrees F.
5. Connector Type(s): Union joint, adjustable angle, rigid back, or rigid bottom selected for ease of reading. Unified-inch screw threads.
6. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
7. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
8. Window: Double strength glass or plastic.
9. Ring: Stainless steel.
10. Element: Bimetal coil.
11. Pointer: Dark-colored metal.
12. Scale: Scale: Select the proper scale range so that the operating temperature of the material being measured will be approximately in the middle of the scale. 100oF range, or as required to span entire normal operating range whichever is greater.
13. Accuracy: Plus or minus 1 percent of scale range.

B. Thermowells.

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing and PVC Piping: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.2 PRESSURE GAGES AND GAGE ATTACHMENTS

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Marsh Bellofram.
 - c. Palmer Wahl Instrumentation Group.
 - d. Trerice, H. O. Co.
 - e. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is required.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Double strength glass or plastic.
10. Ring: Metal, Friction fit.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
12. Scale: Black printing on white. 270-degree arc, 0 to 60 range, 1 psi increments. 0 to 100 psi range, 1 psi increments, or as required for system pressure encountered. Range selected so that operating pressure approximately half of full range or

maximum scale value exceeds maximum pressure, whichever scale range is greater.

- B. Gage Attachments.
 - 1. Siphons: Loop-shaped section of brass pipe with NPS 1/4 pipe threads.
 - 2. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install all equipment in accordance with manufacturer's recommendations.
- B. Thermometers.
 - 1. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
 - 2. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- C. Thermowells.
 - 1. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
 - 2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
 - 3. Install thermowells with extension on insulated piping.
 - 4. Fill thermowells with heat-transfer medium.
- D. Pressure Gauges.
 - 1. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
 - 2. Install valve and snubber in piping for each pressure gage for fluids (except steam).
 - 3. Sight Install valve and syphon fitting in piping for each pressure gage for steam.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION

SECTION 230523
VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Valves for HVAC service.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. HPS: High Pressure Steam. Steam pressure greater than 15 psig.
- D. LPS: Low Pressure Steam. Steam pressure 15 psig and less.
- E. NRS: Non-rising stem.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS

- A. Catalog Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle and globe valves closed to prevent rattling.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single manufacturer.

- B. ASME Compliance:
 1. ASME B1.20.1 for threads for threaded-end valves.
 2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 4. ASME B31.1 for power piping valves.
 5. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for maximum system pressures and temperatures. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valves in Insulated Piping:
 1. Include 2-inch stem extensions.
 2. Ball Valves:
 - a. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
 - b. Memory stops shall be fully adjustable after insulation is applied.
 3. Gate Valves:
 - a. RS Valves in Insulated Piping: Provide 2-inch stem extensions.
- H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BALL VALVES

- A. NPS 2 and Smaller:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves.
 - b. Hammond Valve.
 - c. Jenkins Valves; Crane Energy Flow Solutions.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Stockham; Crane Energy Flow Solutions.
 - g. Watts; a Watts Water Technologies company.
 2. Bronze Ball Valves with Bronze or Brass Trim:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
 3. Bronze Ball Valves with Stainless-Steel Trim:
 - a. Standard: MSS SP-110.

- b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two-piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE.
 - h. Stem: Stainless-steel.
 - i. Ball: Stainless-steel.
 - j. Port: Full.
4. Steel Ball Valve with Stainless-Steel Trim:
- a. Standard: MSS SP-72.
 - b. CWP Rating: 720 psig.
 - c. Body Design: Split body.
 - d. Body Material: Carbon steel, ASTM A 216, Type WCB.
 - e. Ends: Flanged.
 - f. Seats: PTFE.
 - g. Stem: Stainless-steel.
 - h. Ball: Stainless-steel.
 - i. Port: Full.

2.3 BUTTERFLY VALVES

- A. NPS 2-1/2 and Larger, Lug Type:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves.
 - b. Hammond Valve.
 - c. Jenkins Valves; Crane Energy Flow Solutions.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Stockham; Crane Energy Flow Solutions.
 2. 200 CWP Lug Type Butterfly Valve:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast-iron .
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless-steel.
 - g. Disc: Bronze, or stainless-steel.
 3. High Performance 285 CWP Lug Type Butterfly Valve:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 285 psigat 100°F.
 - c. Body Design: Lug-type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: Carbon steel, cast-iron, ductile iron, or stainless-steel.
 - e. Seat: Reinforced PTFE or metal.
 - f. Stem: Stainless steel; offset from seat plane.
 - g. Disc: Bronze or stainless steel.
 - h. Service: Bidirectional.
- B. NPS 2-1/2 and Larger, Grooved Type:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Grinnell Mechanical Products.
 - b. Tyco Fire Products LP.

- c. Victaulic Company.
- 2. 175 CWP Grooved Type Butterfly Valve.
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 175 psig.
 - c. Body Material: Coated, ductile iron.
 - d. Seal: EPDM.
 - e. Stem: Two-piece stainless-steel.
 - f. Disc: Bronze or stainless-steel.

2.4 CHECK VALVES

- A. NPS 2 and Smaller:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves.
 - b. Crane; Crane Energy Flow Solutions.
 - c. Hammond Valve.
 - d. Jenkins Valves; Crane Energy Flow Solutions.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Stockham; Crane Energy Flow Solutions.
 - 2. Class 125, Bronze Swing Check Valve.
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze. Renewable seats and disc.
 - 3. Class 150, Bronze Swing Check Valve.
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- B. NPS 2-1/2 and Larger, Flanged Connections:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves.
 - b. Crane; Crane Energy Flow Solutions.
 - c. Hammond Valve.
 - d. Jenkins Valves; Crane Energy Flow Solutions.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Stockham; Crane Energy Flow Solutions.
 - 2. Class 125, Iron Swing Check Valves.
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged or grooved connections to match fittings specified for associated piping.
 - g. Trim: Bronze.

- C. NPS 2-1/2 and Larger, Pump Discharge:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Metraflex Company (The).
 - c. Milwaukee Valve Company.
 - d. Mueller Steam Specialty.
 - e. NIBCO INC.
 - f. Spence Engineering Company, Inc.
 - 2. All Service:
 - a. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - 1) Standard: MSS SP-125.
 - 2) Why is this 200 psi and not 125. 200 seams excessive.
 - 3) NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - 4) NPS 14 to NPS 24, CWP Rating: 150 psig.
 - 5) Body Material: ASTM A 126, gray iron.
 - 6) Style: Compact wafer.
 - 7) Seat: Bronze.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges to isolate each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
 - 3. Install check valves a minimum of five pipe diameters away from changes of direction, pumps, or equipment that can generate turbulent flow in piping.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL VALVE APPLICATIONS

- A. Drain Valves:
 - 1. Where drain valves are required, include hose end connection and cap with EDPM gasket.
 - 2. Provide drain down valves at the low point in each zone, area of service, or floor level.
 - 3. Provide drain down valves to drain equipment.
- B. Gauge Stop Valves:
 - 1. Size to match gauge connection.
- C. Strainer Blowdown Valves:
 - 1. Match blowdown connection.
 - 2. Provide hose end connection and cap with EDPM gasket for valves 1-inch and below.
- D. Provide valves for isolation of services as shown on Drawings and in accordance with the following:
 - 1. As required to individually isolate all equipment and maintainable devices including automatic air vents and hydronic control valves.
- E. Provide valves where recommended by equipment manufacturer's installation instructions.

3.5 VALVE SCHEDULE

- A. If valve type shown on drawings is different than type indicated below, notify Engineer prior to ordering to verify type.
- B. General Heating Water or Condenser Water Service.
 - 1. General Shutoff Service.
 - a. NPS 2 and smaller: Ball Valves with Bronze or Brass Trim
 - b. NPS 2-1/2 and Larger: 200 CWP Lug Type Butterfly Valve, 175 CWP Grooved Type Butterfly Valve
 - 2. Boiler Shutoff Service.
 - a. NPS 2-1/2 and Larger: Class 125, RS, Iron Gate Valve.
 - 3. Check Valve Service:
 - a. NPS 2 and Smaller: Class 125, Bronze Swing Check Valve.
 - b. NPS 2-1/2 and Larger, Standard Service: Class 250, Iron Swing Check Valve.
 - c. NPS 2-1/2 and Larger, Pump Discharge: Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat.
 - 4. Drain, Gauge Stop, Strainer Blowdown: NPS 2 and smaller: Ball Valves with Bronze or Brass Trim

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Design and installation of hangers and supports for HVAC piping and equipment provided in Division 23.

1.2 DEFINITIONS

- A. ASCE: American Society of Civil Engineers.
- B. ASME: American Society of Mechanical Engineers.
- C. ASTM: American Society for Testing and Materials.
- D. MFMA: Metal Framing Manufacturers Association.
- E. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Supports for multiple pipes, including pipe stands, shall be capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Equipment supports shall be capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 - General HVAC Provisions Submittal requirements indicated by column number designation as follows:
 - 1. Materials List.
 - 2. Catalog Data.
 - 3. Detailed Data.
 - 4. Performance Data.
 - 5. Wiring Diagrams.
 - 6. Shop Drawings.
 - 7. Installation Instructions.
 - 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Pipe Hangers and Supports		X						
Thermal Hanger Shield Inserts		X						
Fabricated framing & support assemblies								X

- B. Shop Drawings:
 - 1. Plans showing type and location of supports and assemblies. Provide full or half size copies of piping plans from the Contract Documents or coordination drawings, showing location and type of each support component to be installed. Drawings shall consist of mechanically reproduced copies of the Contract Documents, or new drawings custom drafted specifically for the Work of this Project. Each drawing shall be printed on a single sheet.
 - 2. Detail fabrication and assemblies for support assemblies including metal framing systems, equipment supports, trapeze hangers, pipe support stands to comply with performance requirements and design criteria. Assemblies may be pre-engineered or custom designed for the application.
 - 3. Detail anchorages and attachments to structure. Where walls, floors, slabs or supplementary steel work are used for support, details of acceptable attachment methods must be included and approved before the condition is accepted for installation. Drawings must include spacing and static loads at all attachment and support points.

1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper-Coated Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. Manufactured Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-line, an Eaton business.
 - b. Thomas & Betts Corporation, a member of the ABB Group.
 - c. Unistrut, part of Atkore International.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with in-turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Pre-Galvanized Hot Dipped, ASTM A653, 0.75 MIL

2.4 INSULATION INSERTS

- A. General: Insulation insert for use with MSS Type 40 protection shield.
- B. Insulation-Insert Material for Cold Piping:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Foamglas.
 2. ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength and vapor barrier.
 3. ASTM C1126 Type III phenolic foam with factory laminated ASJ.
 - a. 1-1/2" to 2-1/2" pipe size: 32 psi at load point.
 - b. 3" to 6" pipe size: 85 psi at load point.
- C. Insulation-Insert Material for Hot Piping, 200°F and less:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Insultherm.
 - b. Johns Manville.
 - c. Resolco, Inc.
 2. ASTM C1126 Type III phenolic foam with factory laminated ASJ.
 - a. Maximum Temperature: 220°F.
 - b. Maximum Load:
 - 1) 1-1/2" to 2-1/2" pipe size: 32 psi at load point.
 - 2) 3" to 6" pipe size: 85 psi at load point.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying. Coordinate with Section 23 05 48 - Vibration and Seismic Controls for HVAC for interrelated work.
- H. Install building attachments within concrete slabs or to structural steel where possible. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes.

- K. Insulated Piping:
 - 1. Piping Operating less than 180 degrees:
 - a. All Piping 1-1/2-inches and Larger: Provide Insulation Insert with MSS Type 40 protection shield.
 - b. All Piping 1-1/4-inches and smaller: Provide MSS Type 40 protection shield.
 - 2. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS (Nominal Pipe Size) 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - 3. Insulation Inserts: Same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply

galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER SPACING

A. Spacing Table

HYDRONIC PIPING SPACING TABLE	Maximum Horizontal Span	Maximum Vertical Spacing
Carbon Steel		
1-1/4 inch and smaller	7 feet	15
1-1/2 inch to 2-1/2 inch	10 feet	15
3 inch and larger	12 feet	15
Copper Tubing		
3/4 inch and smaller	5 feet	10
1 inch to 2 inch	7 feet	10
2-1/2 inch and larger	10 feet	10

3.7 ROD SIZES

- A. Select rod diameter to not exceed the maximum safe load listed in Table 2 of MSS SP-58-2009.

3.8 HANGER AND SUPPORT TYPE SCHEDULE

- A. Single Pipe, Hung and Uninsulated.
1. NPS 1/2 to NPS 3: Adjustable Steel Band Hanger, MSS Type 7.
 2. NPS 4 and Larger: Steel Clevis, MSS Type 1.
- B. Single Pipe, Hung and Insulated.
1. Operating Temperature Less Than 140 Degrees: Steel Clevis, MSS Type 1.
 2. Operating Temperature 140 Degrees and Above.
 - a. NPS 1/2 to NPS2: Steel Clevis, MSS Type 1.
 - b. NPS 3 and Larger: Adjustable Roller Hanger: Type 43.
- C. Multiple Pipe Trapeze or Pipe Rack: Trapeze Hanger, MSS Type 59.
1. Uninsulated Piping: Steel Strap.
 2. Insulated Piping: Adjustable Roller, MSS Type 43.
- D. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- F. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- G. Use copper-plated pipe hangers and attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. To eliminate the need for seismic restraint, for piping installation where the distance from

the top of the pipe to the structure is 12 inches or less for the entire run, select hanger-rod and building attachments to allow pipe movement without stress on hangers and attachments.

- J. Hanger-Rod Attachments: Unless otherwise indicated, provide the following types:
 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450°F (49 to 232 deg C) piping installations.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F (49 to 232 deg C) piping installations.
- K. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications.
- L. Comply with MFMA-103 for metal framing system selections and applications.

END OF SECTION

SECTION 230548

VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Design and installation of equipment attachment to structure, vibration isolation systems, and seismic restraint components listed for new mechanical equipment, ductwork, piping, and related systems provided in Division 23 as scheduled or described herein.
 2. Related Requirements: Refer to Section 230500, General HVAC Provisions; Roof Curbs for seismic restraint of roof mounted equipment that is not equipped with vibration isolation.

1.2 DEFINITIONS

- A. OSHPD: Office of Statewide Health Planning and Development (for the State of California).

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal:
1. Provide a delegated submittal package comprised of drawings, details, and calculations signed and sealed by an engineer specializing in the associated work and registered in Oregon. Submittals shall indicate full compliance with the device specification in Part 2. Any deviation shall be specifically noted and subject to engineer approval. Submittals shall include device dimensions, placement, and attachment and anchorage requirements.
 2. All restraining devices shall have a pre-approval number from California OSHPD or some other organization acceptable to the Authority Having Jurisdiction. Where pre-

approved devices are not available, provide submittals based on independent testing or calculations stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of Oregon.

3. Ductwork and Piping Restraint:
 - a. Provide full or half size copies of ductwork and piping plans from the Contract Documents or coordination drawings, showing location and type of each vibration isolation component and seismic restraint to be installed. Drawings shall consist of mechanically reproduced copies of the Contract Documents, or new drawings custom drafted specifically for the Work of this Project. Each drawing shall be printed on a single sheet.
 - b. Provide piping and ductwork restraint assembly construction and installation details. Assemblies may be pre-engineered or custom designed for the application.
 - c. Provide spring hangers or spring floor supports for the first three supports for piping and ductwork from any equipment that produces vibration. The spring deflection shall match the equipment isolation deflection.
 - d. Provide spring hangers or spring floor supports for the first three supports from any vertical riser greater than 20 feet in elevation.
 - e. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
4. Equipment Restraint.
 - a. Select vibration isolators and accessories as scheduled and as required to meet seismic restraint requirements.
 - b. Provide equipment seismic restraint assembly construction and installation details. Assemblies may be pre-engineered or custom designed for the application. Include method of attachment to supporting structure.
 - c. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
 - d. For equipment mounted outdoors, include wind load in determining the necessary attachment and restraint requirements.
5. Calculations: Provide design calculations to verify that seismic and wind load restraint will comply with the current Oregon Structural Specialty Code for the site and the building type listed.

1.4 INFORMATIONAL SUBMITTALS

- A. Provide three copies of the seismic restraint system Engineer's inspection report.
- B. Provide a written authorization letter from the seismic restraint Engineer authorizing a representative to provide the inspection if a designated representative is used. Describe the representative's qualifications.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer or appropriately licensed design professional to design seismic and wind- load control system. Conform to 23 05 00 - General HVAC Provisions, Delegated Design.
 1. Provide seismic and wind load design in accordance with the current Oregon State Structural Specialty Code and ASCE/SEI 7.

- B. Seismic Design Calculations:
 - 1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities.
 - a. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
 - b. Risk Category: II
 - c. Component Importance Factor (Ip).
 - 1) As required by Code.

2.2 ISOLATION PADS

- A. Elastomeric Isolation Pads: (EP-1).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Vibro-Acoustics.
 - 2. Basis of Design: Mason Type Super WM Pads.
 - 3. Fabrication: Neoprene waffle pad. 3/4-inch thick. 40 durometer. 1/4-inch thick steel load distribution plate.
 - 4. Size: Factory or field cut to match requirements of supported equipment.
 - 5. Accessories: Bolt isolator washer bushings where equipment is bolted to structure. Similar to Mason Type HG.

2.3 FREE STANDING SPRING MOUNTS

- A. Laterally Stable, Open-Spring Mount: (SM-1).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Vibro-Acoustics.
 - 2. Basis of Design: Mason Industries Type SLF.
 - 3. General: Free-standing spring isolators. Laterally stable without housing. Complete with molded neoprene cup or 1/4-inch neoprene acoustical friction pad between the baseplate and the support.
 - 4. Provided with leveling bolts rigidly bolted to the equipment.
 - 5. Spring diameters not less than 80% of the spring height at rated load.
 - 6. Minimum additional travel to solid equal to 50% of the rated deflection.

2.4 SPRING HANGERS

- A. Spring and Neoprene Hanger with Vertical Restraint: (SH-1).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Vibro-Acoustics.
 - 2. Basis of Design: Mason Industries Type RW30N.
 - 3. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
10. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.5 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Vibro-Acoustics.
- B. Basis of Design: Mason Industries SCB/H.
- C. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.6 ANCHOR BOLTS

- A. Mechanical Anchor Bolts.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-line, an Eaton business.
 - b. Hilti, Inc.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries.
 - e. Vibro-Acoustics.
 2. Basis of Design: Mason Industries SASE, SAST.
 3. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.
- B. Adhesive Anchor Bolts.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries.
 - d. Vibro-Acoustics.
 2. Basis of Design: Mason Industries SRA.
 3. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.7 SEISMIC-RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

PART 3 EXECUTION

3.1 GENERAL

- A. Isolated and restrained equipment, duct and piping located on roofs must be attached to the structure. Intermediate supports between the restraint and structure that are not attached to the structure must be approved the project structural engineer or by the restraint manufacturer.
- B. Block and shim all bases level so that all ductwork, piping and electrical connections can be made to a rigid system at the proper operating level before isolators are adjusted. Ensure that there are no rigid connections or incidental physical contacts between isolated equipment and the building structure or nearby systems.
- C. Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.

3.2 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine rough-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on seismic design documents to receive them and where required to prevent buckling of hanger rods due to seismic forces.

- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Install all equipment in accordance with manufacturer's recommendations and as shown on seismic design documents.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Elastomeric Isolation Pads: Provide for entire weight bearing surface of equipment base, or as recommended by equipment manufacturer.
- D. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Ductwork Restraints:
 - 1. Space lateral supports a maximum of 40 feet (12 m) on center and longitudinal supports a maximum of 80 feet (24 m) on center.
 - 2. Brace a change of direction longer than 12 feet (3.7 m).
 - 3. Provide spring hangers supports for the first three supports from any equipment that produces vibration.
- F. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet (12 m) on center and longitudinal supports a maximum of 80 feet (24 m) on center.
 - 3. Brace a change of direction longer than 12 feet (3.7 m).
 - 4. Provide spring hangers or spring floor supports for the first three supports from any equipment that produces vibration.
 - 5. Provide spring hangers or spring floor supports for the first three supports from any vertical riser 1-1/2 inch and larger and greater than 20 feet in elevation.
- G. Install cables so they do not bend across edges of adjacent equipment or building structure.
- H. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- I. Install bushing assemblies for anchor bolts for floor-mounted equipment or rigid equipment bases that are mounted on resilient pads and mounting gaskets, arranged to provide resilient media between anchor bolt and mounting hole.
- J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

- K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to at upper truss chords of bar joists, or at concrete members.

3.5 FIELD QUALITY CONTROL

- A. After installation of seismic and vibration control devices is complete and verified as fully functional, Contractor shall notify Engineer and seismic restraint designer that equipment is ready for inspection.
- B. Seismic restraint system Engineer shall inspect the installation to verify that seismic restraints are installed and adjusted in conformance with approved shop drawings and no additional restraints are necessary based on field conditions. Alternately, the restraint system Engineer may designate a qualified representative to provide the inspection. The representative may not be an employee of the installing Contractor or Subcontractor.
- C. Prepare inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 VIBRATION CONTROL AND SEISMIC RESTRAINT DEVICE SCHEDULE

EQUIPMENT	SPECIFICATION	SLAB ON GRADE	ABOVE GRADE
		STATIC DEFL. (IN)	STATIC DEFL. (IN)
HEAT PUMPS, FAN-COILS, FAN POWERED BOXES - SUSPENDED	SH-1	--	1.5"
ENERGY RECOVERY UNITS - SUSPENDED	SH-1	--	1.5"
MAKEUP AIR UNITS - SUSPENDED	SH-1	--	1.5"
IN-LINE PUMP, SUSPENDED, > 1/4 HP	SH-1	--	0.75"
IN-LINE PUMP, FLOOR MOUNTED, >3 HP	SM-1	1.0"	--
COOLING TOWER	EP-1	0.25"	--

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Duct labels.
 - 4. Valve tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 PRODUCTS

2.1 GENERAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Marking Services, Inc.
 - 3. Seton Identification Products.

2.2 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
 - 2. Engraved to show white lettering on black background except for labels attached to ceiling grid or located within finished spaces shall have black lettering on white background.
 - 3. Maximum Temperature: Able to withstand temperatures up to 160°F.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-

quarters the size of principal lettering. Lettering on labels attached to ceiling grid largest size practical.

6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment number.
- C. Equipment Label Schedule: For each item of equipment to be labeled, prepare equipment label schedule on 8-1/2-by-11-inch. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Yellow.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Automatic Balance Damper.

2.5 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Marking Services Inc.
 - 3. Seton Identification Products.
- B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Polished brass, 0.025-inch aluminum and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Tag Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch.
 - 3. Fasteners: Brass wire-link chain or S-hook.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels on piping in mechanical rooms at intervals not to exceed 25 feet.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule: Letter and background color in accordance with ANSI A13.1.

3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts at locations where Automatic Balance Dampers are installed.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, faucets, convenience and lawn-watering hose connections, and isolation valves for HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves with captions as indicated in the following subparagraphs:
 - 1. Valve-Tag Information: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch valve tag numbers.
 - a. Valve-Tag Information: Stamped or engraved with 1/4-inch letters and 1/2-inch valve tag numbers as listed below:
 - b. Valve tag number.
 - c. System abbreviation.
 - d. Area served.
 - e. Normal position.

END OF SECTION

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing air systems and equipment.
 - 2. Balancing hydronic piping systems and equipment.
 - 3. Testing, adjusting, and balancing existing systems and equipment.
 - 4. Control system measurement and verification.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB Specialist: An independent entity meeting qualification to perform TAB work.
- E. TAB Project Supervisor: Certified individual employed by balancing contractor having administrative and technical responsibility for work performed under this Section.
- F. TAB: Testing, adjusting, and balancing.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in Part 1 "Quality Assurance" and Part 3 "TAB Specialist."
- B. Pre-construction TAB Reports:
 - 1. Existing Conditions TAB Report: Within 30 days of Contractor's Notice to Proceed, submit the as specified in Part 3 "Procedures for Testing, Adjusting, and Balancing Existing Systems."
 - 2. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3 "Examination."
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Instrument Calibration Report: Within 60 days of Contractor's Notice to Proceed. Report to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.

3. Application.
4. Dates of use.
5. Dates of calibration.

F. Progress Reports: Submit the as specified in Part 3 "Progress Reporting."

- G. TAB reports.
1. Preliminary equipment measurements TAB report.
 2. Draft TAB Report.
 3. Certified Final TAB report.

1.4 QUALITY ASSURANCE

- A. All work under this Section shall be performed under the direction of the Certified TAB Supervisor.
- B. TAB Specialists Qualifications: Certified by AABC or NEBB.
1. TAB Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.
 2. TAB Technician: Employee of the TAB specialist working under the supervision of the TAB Supervisor.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1.5 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 TAB SPECIALISTS

- A. Subject to compliance with requirements, engage one of the following:
1. Air Balancing Specialties.
 2. Air Introduction and Regulation, Inc.
 3. Neudorfer Engineering, Inc.
 4. Precision Test & Balance, Inc.

3.2 EXAMINATION

- A. Contract Document Examination:
1. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
 2. Confirm that balancing devices and provisions are included to facilitate TAB work. Provide listing of any devices and provisions required that are on included in the Contract Documents.
 3. Contract Documents Examination Report: Based on examination of the Contract Documents, prepare a report on the adequacy of design for systems balancing

devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

- B. Construction Examination:
1. Examine the approved submittals for HVAC systems and equipment.
 2. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
 3. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
 4. Examine ceiling plenums, underfloor air plenums, and vertical shaft plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed airtight as required.
 5. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
 6. Examine test reports specified in individual system and equipment Sections.
 7. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
 8. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
 9. Examine control valves for proper installation and orientation for their intended function of throttling, diverting, or mixing fluid flows. Verify the pipe connections are in accordance with manufacturers recommendations.
 10. Examine system pumps to ensure absence of entrained air in the suction piping.
 11. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

- A. Strategies and Procedures Plan: Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
 2. Strategies and step-by-step procedures for balancing the systems.
 3. Instrumentation to be used.
 4. Sample forms with specific identification for all equipment.
- B. Prepare system-readiness checks of HVAC systems and equipment to be executed by the Mechanical Contractor to verify system readiness for TAB work. Include, at a minimum, the following:
1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Clean filters are installed.
 - d. Fans are operating, free of vibration, and rotating in correct direction.
 - e. Automatic temperature-control systems are operational.
 - f. Suitable access to balancing devices and equipment is provided.
 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.

- c. Water treatment is complete.
- d. Systems are flushed, filled, and air purged.
- e. Strainers are pulled and cleaned.
- f. Control valves are functioning per the sequence of operation.
- g. Shutoff and balance valves have been verified to be 100 percent open.
- h. Pumps are started and proper rotation is verified.
- i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- j. Variable-frequency controllers' startup is complete, and safeties are verified.
- k. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, install test ports and duct access doors as required in Section 233300 - Air Duct Accessories. Otherwise, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 - Duct Insulation, Section 230716 - HVAC Equipment Insulation, and Section 230719 - HVAC Piping Insulation.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- C. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- D. Verify that motor starters are equipped with properly sized thermal protection.
- E. Check dampers for proper position to achieve desired airflow path.
- F. Check for airflow blockages.
- G. Check condensate drains for proper connections and functioning.

- H. Check for proper sealing of air-handling-unit components.
- I. Verify that air duct system is sealed as specified in Section 233113 - Metal Ductwork.
- J. Fan Pressure Measurements:
 1. Measure static pressure directly at the fan outlet or through the flexible connection.
 2. Measure static pressure directly at the fan inlet or through the flexible connection.
 3. Measure static pressure across each component that makes up and air-handling system.
- K. Air Inlets and Outlets:
 1. Supply Diffusers: Set airflow patterns of adjustable outlets for proper distribution without drafts.
- L. Control Parameters and Setpoints:
 1. Minimum Ventilation Rates: Measure and adjust outside-air, return-air, and relief-air dampers for proper position to achieve minimum outdoor-air conditions. Determine setpoint values for specific control sequences controlling damper operation.
 2. Record verification measurement, calibration parameters, and setpoints in Final TAB Report.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 1. Check liquid level in expansion tank.
 2. Measure and adjust expansion tank bladder pressure. Measure bladder pressure with system isolation valve closed and vent valve open to remove system pressure from bladder. Adjust bladder pressure to 2 psig greater than that make-up water pressure indicated on drawings. Document bladder pressure in final TAB report.
 3. Check highest vent for adequate pressure.
 4. Check flow-control valves for proper position.
 5. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 6. Verify that motor starters are equipped with properly sized thermal protection.
 7. Check that air has been purged from the system.
- D. Flow Adjustments:
 1. Perform temperature tests after flows have been balanced.
 2. Position 3-way control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 3. For pressure independent flow devices, measure differential pressure and verify that it is within manufacturer's specified range.
 4. Adjust memory stops on balancing devices.
- E. Pump Pressure Measurements:
 1. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 2. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.

3. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

F. Record verification measurement, calibration parameters, and setpoints in Final TAB Report.

3.7 PROCEDURES FOR COOLING TOWERS

- A. Balance total condenser-water flows to towers. Measure and record the following data:
1. Condenser-water flow to each cell of the cooling tower.
 2. Entering- and leaving-water temperatures.
 3. Wet- and dry-bulb temperatures of entering air.
 4. Wet- and dry-bulb temperatures of leaving air.
 5. Condenser-water flow rate recirculating through the cooling tower.
 6. Cooling-tower spray pump discharge pressure.
 7. Condenser-water flow through bypass.
 8. Fan and motor operating data.

3.8 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
1. Measure and record entering- and leaving-water temperatures.
 2. Measure and record water flow.
 3. Record relief valve pressure setting.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
1. Entering- and leaving-water temperature.
 2. Water flow rate.
 3. Dry-bulb temperature of entering and leaving air.
 4. Wet-bulb temperature of entering and leaving air for cooling coils.
 5. Airflow.
- B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
 2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Airflow.
 3. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.

3.10 PROCEDURES FOR MOTORS

- A. Motor Measurement and Verification:
 - 1. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - a. Manufacturer's name, model number, and serial number.
 - b. Motor horsepower rating.
 - c. Motor rpm.
 - d. Phase and hertz.
 - e. Nameplate and measured voltage, each phase.
 - f. Nameplate and measured amperage, each phase.
 - g. Starter size and thermal-protection-element rating.
 - h. Service factor and frame size.
 - 2. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.
- B. Motor Speed Adjustments:
 - 1. Obtain approval from Engineer for adjustment of fan motor speeds higher than the motor synchronous speed. indicated speed for induction motors.
 - 2. Obtain approval from Engineer prior to making fan-speed adjustments that result in motor operation above the motor RLA. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required motor amperage.

3.11 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 - 1. Verify location and installation of sensors to ensure that they sense intended temperature or pressure.
 - 2. Verify that the system static pressure sensor is located in the duct or piping system as specified or as shown on drawings.
 - 3. Verify the operation of valve and damper actuators. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions in Final Report.

3.12 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform testing and supply air flow measurement of existing water source heat pump fan coils units prior to start of demolition or alteration of existing equipment.
- B. Prepare an Existing Conditions TAB Report documenting inspections and measurements.

3.13 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent or minus 5 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Condenser Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.14 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.

- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers. Test reports shall be fully executed reports forms confirming to standard NEBB or AABC documentation standards.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Engineer's name and address.
 - 6. Contractor's name and address.
 - 7. Report date.
 - 8. Signature of TAB supervisor who certifies the report.
 - 9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 10. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 11. Nomenclature sheets for each item of equipment.
 - 12. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 13. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 14. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.

- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Balancing stations.
 - 6. Position of balancing devices.

- E. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.15 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION

SECTION 230713

DUCT INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes insulation of HVAC ductwork.

1.2 ACTION SUBMITTALS

- A. Provide submittals in accordance with Section 230500 - General HVAC Provisions as follows:
 1. Provide catalog data for all products. Indicate thermal conductivity, water vapor permeance, and jackets (both factory and field applied) if any.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. If duct leak testing is required, schedule insulation application after systems are tested and, where required. Insulation application may begin on segments that have satisfactory test results.

- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Insulation jacket material shall be paintable where painting of the insulation jacket is specified.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville, a Berkshire Hathaway company.
 - c. Knauf Insulation.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville, a Berkshire Hathaway company.
 - c. Knauf Insulation.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82 deg C).
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
 - 2. Service Temperature Range: Minus 50 to plus 220°F (Minus 46 to plus 104 deg C).
 - 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 4. Color: White.

2.4 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121 deg C).
 - 4. Color: Aluminum.

2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

2.7 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 SECUREMENTS

- A. Insulation Pins and Hangers:
 - 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, and manufacturer's recommended percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install support pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface.

Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner reserves the right to perform tests and inspections.
- B. Tests will include removing field-applied jacket and insulation in layers in reverse order of their installation for each duct system schedule as directed by the Owner.
- C. If sample inspection reveals noncompliance with requirements, all similar insulation applications will be considered defective Work and will be replaced at no expense to the Owner.

3.7 DUCT INSULATION SCHEDULE

- A. Insulate all plenums and ductwork as scheduled with the following exceptions.
 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums and casings.
 4. Flexible connectors.
 5. Vibration-control devices.
 6. Factory-insulated access panels and doors.
- B. Insulate ductwork located indoors in conditioned spaces:
 1. Supply Air.
 - a. Insulate ductwork where the air supply temperature is:
 - 1) More than 10oF below that space cooling temperature setpoint or below 60oF.
 - 2) More than 15oF above the space heating temperature setpoint.
 - b. Concealed ductwork:
 - 1) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density, FSK jacket.
 2. Exhaust ductwork downstream of energy recovery units:
 - a. Insulate same as insulated supply air ductwork.

END OF SECTION

SECTION 230800

COMMISSIONING OF HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes Commissioning activities required for work of Division 23 Sections including but not limited to construction checks, equipment start-up, functional testing, and operator training.
 - 1. Comply with Section 01 91 13 – General Commissioning Requirements for Commissioning activities for Division 23 work.

1.2 SEQUENCING

- A. Provide written notification to Commissioning Provider (CxP) in advance of significant project dates as directed and as listed below.
 - 1. Two weeks prior to start-up of energy recovery ventilator units, water source heat pumps, exhaust fans, cooling towers, boilers, and pumps
 - 2. Four weeks prior to installation of lay-in ceiling tiles or other partial concealment of equipment to be commissioned
 - 3. Four weeks prior to any system ready for balancing

1.3 SUBMITTALS

- A. Provide control system custom software, hardware, and technical manuals as necessary for development of Commissioning activities. Control system submittals include but are not limited to operating sequences, point database, workstation remote access, on-site custom programming/editing software, and programming and operations manual as necessary for development of Commissioning activities. Submit a minimum of 12 weeks prior to equipment start-up.
- B. Provide sample control verification report to Commissioning Provider 12 weeks prior to substantial completion. Submittal shall show format and content of Final Verification Report.
- C. Provide submittals of systems being commissioned to Owner's Authorized Representative as required by Section 01 91 13.
- D. Provide electronic copies (or hard copies where appropriate) of control system final configuration parameters, programs, databases, files, and electrical data as necessary to reconfigure and/or replace control components upon device failure.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide all necessary control hardware, software, and temporary licenses to enable Commissioning Provider to conduct activities and to fully access any electronic control systems furnished for this project. Commissioning Provider's laptop computer may be used for access if software and hardware systems provided are compatible with existing computer configuration, otherwise furnish laptop computer where required for duration of project.

- B. Provide minimum of two HVAC control operator interface sites for both on-site and remote access as described below:
 - 1. Commissioning Provider Access Functions: Review and modification of control programming, monitoring of control system operations, review and modification of software database, setup, and monitoring trend data in tabular and graphical formats.
 - 2. Remote Access: Remote access using Internet and shall include all functions described above.
 - 3. Provide credentials for Commissioning Provider. Security access level shall be suitable to perform necessary commissioning functions.
 - 4. Provide labor required to install hardware and software on personal computers at Commissioning Provider's office. Software will be manufacturer's most recent version and will be compatible with the CxP's personal computers. Provide Commissioning Provider with two hours training after fully functional remote access is established.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Manufacturer's Representative to execute Construction Checklists and perform operational training as specified in Division 23 including the following systems:
 - 1. Energy recovery units
 - 2. Makeup air units
 - 3. Water source heat pumps
 - 4. Exhaust fans
 - 5. Cooling towers and associated pumping
 - 6. Hydronic boilers and associated pumping
 - 7. Building automation control system
 - 8. Variable frequency drives

3.2 CONSTRUCTION CHECKLISTS

- A. Contractor shall execute as required by Section 01 91 13. Construction Checklists for each system commissioned will be prepared by Commissioning Provider during construction.

3.3 CONTROL VERIFICATION REPORTS

- A. Building Automation System: BAS control contractor shall perform verification of the function and performance of control hardware and software. Provide verification report demonstrating proper system installation and operation. Verification report shall include the following:
 - 1. Network Communication: Verify that all network devices properly communicate on network. Verify communication speed and reliability is acceptable.
 - 2. Input and Output Verification:
 - a. Verify that all input and output points are indicating properly. Verification tests shall be "end-to-end," meaning field measurement to workstation graphic display value.
 - b. Calibrate all analog inputs. Acceptance accuracy shall be as specified for product accuracy. Repair or replace all devices that do not conform to specified accuracy.

- c. Operate all analog outputs from 0% to 100% of operating range. Verify that controlled device operates over the entire output range and that maximum and minimum operating conditions are achieved.
- d. Valves and dampers shall close fully and provide tight shutoff. Leakage rates shall not exceed specified values.
- e. Verify that all digital outputs operate controlled devices.
- 3. Sequence of Operation Verification: Systematically verify automatic control sequence of operation functions in field after installation is complete. Verification shall include:
 - a. Time scheduling.
 - b. Operating modes.
 - c. Tune and adjust control loops and control sequences to optimize efficiency and performance. Control loops shall be stable and maintain desired setpoints.
- 4. Trending: Confirm trending utilities storage of operating data as required to verify operation and performance of control modes, sequence, and loops. Meet with Owner and CxP to review configuration, parameter interval, and duration prior to trend setup.
- 5. Operator Interface: Review function of operator interface. Confirm that graphic operator interface accurately depicts as-constructed system configuration and that all required content is displayed and functions as intended.
- 6. Alarms: Confirm alarm utilities are configured as required, alarm conditions are displaying in alarm logs and on graphic displays, and provide annunciation and reporting as required. Meet with Owner and CxP to review configuration parameters prior to alarm utility setup.
- 7. Coordination: Assist balancing contractor with development of control setpoints and parameters as specifically indicated or otherwise required to provide Sequence of Operation. Setpoints would include but would not be limited to actuator positions required to provide minimum ventilation rates, supply air pressure setpoints for variable air volume air distribution systems, and terminal unit calibration parameters.
- 8. Controls Verification Report: After system operation is completely verified, provide written certification to Owner that systems have been fully tested, are operating according to specifications, and ready for functional testing. Include documentation to the Commissioning Provider detailing verification results. Report shall include:
 - a. Updated control construction drawings and equipment data that incorporates all changes made during construction.
 - b. Printed as-built control code.
 - c. Printed point data base.
 - d. Input/Output Verification Log: Submit point verification log including point identification, control system readout value, verification measurement, and required calibration offset where applied.
 - e. Sequence of Operation Verification: Submit verification test report listing complete text of control sequence and test results. Verify all specified control sequences.
 - f. Trend Logs: Submit printed trend reports for the following:
 - 1) Time schedules. Seven-day log demonstrating that equipment operates according to programmed time schedules.
 - 2) Automatic control sequences. Trends shall be set-up as follows:
 - a) Analog Control: Points that modulate over time shall be sampled at appropriate intervals and durations to demonstrate proper operating sequences. For example, a discharge temperature control loop would require trending during the morning warm-up mode and normal daytime operation mode. Each trend shall include all measured variables, control output signal, actual output signal, and controlled variable.
 - b) Digital Control: Dual-state control or monitoring points shall be recorded as COV (+) or change of value meaning that the changed parameter only needs to be recorded after the value changes from its previous state. A

minimum of one week of samples shall be provided to properly demonstrate equipment cycles, modes, and schedules.

- g. Include trend graphs as described below:
 - 1) Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.
 - 2) Indicate engineering units of the y-axis values; e.g., degrees F., inches w.g., Btu/lb, percent wide open, etc.
 - 3) The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.
 - 4) All points trended for one HVAC subsystem; e.g., air handling unit, chilled water system, etc. shall be trended during the same trend period.
 - 5) Each graph shall be clearly labeled with HVAC subsystem title, date, and times.
- h. List of incomplete work.
- 9. Demonstration: Demonstrate operation of control system to Engineer, Commissioning Provider, and Owner including:
 - a. Menu functions.
 - b. Point overrides.
 - c. Control loop response after point modification.
 - d. Alarm response time.

3.4 FUNCTIONAL TESTING

- A. Contractor shall assist Commissioning Provider with functional testing as required by Section 01 91 13. Functional Test Plans for each system being commissioned will be prepared by Commissioning Provider during construction and will generally include a rigorous verification of instrument calibration, equipment performance, packaged equipment control system operations, automatic control sequence of operations, fire and life safety sequences, and operator interface functions. Commissioning Provider will supervise and document functional testing. Contractor shall provide qualified technicians to assist Commissioning Provider during on-site testing and perform the following functions.
 - 1. Operate equipment and systems as necessary to conduct testing.
 - 2. Manipulate control parameters to simulate test conditions as detailed in Functional Test Plans.
 - 3. Access control programming and database as required to verify control configuration or to correct observed deficiencies.
 - 4. Create graphic displays and/or trend report as required to document test results.
 - 5. Provide proprietary hardware and software as needed to interface with manufacturer's packaged control systems.
- B. Labor required for retesting due to failure of equipment, or systems not performing in accordance with Contract Documents shall be provided at no additional cost to Owner.

3.5 OPERATIONS AND MAINTENANCE TRAINING

- A. The Contractor shall provide operation and maintenance instruction to Owner's personnel as required by Division 01 and 23.

3.6 SCHEDULE OF SYSTEMS BEING COMMISSIONED

- A. Commission systems and equipment listed below, including associated equipment, piping, ductwork, and control systems.

B. HVAC Systems: All HVAC systems, equipment, and controls

END OF SECTION

SECTION 230923

BUILDING AUTOMATION SYSTEMS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Work hereunder includes removal of existing building controls and provision of a complete and operational, fully tested, distributed logic, building automation system (BAS) for control of systems and equipment specified in Division 23. Associated work includes but is not limited to:
1. A network of stand-alone, microprocessor-based building controllers, advanced application controllers, and application specific controllers.
 2. Communication, control wiring, power circuits, power supplies, and power wiring as required.
 3. Building operation and energy management software and related programming including complete licensing agreement for complete use and access of software required for installation, configuration, programming, and operation.
 4. Field Mounted Devices as specified in Section 230925 - BAS Field Mounted Devices for HVAC.
 5. Control sequences as specified in Section 230929 - BAS Sequence of Operations for HVAC.
 6. Other materials and devices not shown as part of other work but necessary to provide mechanical and electrical system control and monitoring sequences specified.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Control Contractor to coordinate with other trades to ensure delivery and correct installation of products furnished but not installed under this section. Coordination to include a review of schedule, manufacturer's installation requirements, and equipment locations. Such products include but are not limited to the following:
1. Control Valves.
 2. Actuators.

1.3 RELATED SECTIONS

- A. Section 230925 - BAS Field Mounted Devices for HVAC.
- B. Section 230929 - BAS Sequence of Operations for HVAC.

1.4 SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 230500 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
1. Materials List.
 2. Catalog Data.
 3. Product Data.
 4. Performance Data.
 5. Wiring Diagrams.
 6. Shop Drawings.

- 7. Installation Instructions.
- 8. Special Requirements listed herein.
- 9.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products This Section								X

- B. Special Requirements:
1. Provide all control submittals including Sections 23 09 23 - Building Automation Systems for HVAC, 23 09 25 - BAS Field Mounted Devices for HVAC, and 23 09 29 - BAS Sequence of Operations for HVAC as a single package.
 2. Submittals prior to starting work:
 - a. Submit in accordance with Section 01 33 00 - Submittal Procedures Division 01 and Section 230500 - General HVAC Provisions within 6 weeks of project award.
 - b. All required schematics and plans prepared on AutoCAD release 12 or higher.
 - c. When manufacturers' product information applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the pertinent specification or drawing.
 - d. Building Automation System Hardware:
 - 1) Provide a complete bill of materials of building automation control system hardware indicating quantity, manufacturer, model number, and technical data. Technical data shall include performance curves, product specifications sheets, and installation/maintenance instructions.
 - 2) Network Communication Diagrams: Provide schematic diagram showing all BAS panels, communications cabling, and termination points. Identify power requirements and power source for each BAS panel. Identify equipment each BAS panel is controlling. Show termination numbers.
 - 3) Provide plans indicating locations of all BAS hardware.
 - 4) Provide panel interior and exterior layout details for prefabricated control panels. Details shall include equipment layout and routing of wiring.
 - 5) Provide files for programming manuals for each BAS controller furnished.
 - 6) Provide a listing and description of all available training programs. Indicate a cost for each location that the training program is available.
 - e. Controlled Systems:
 - 1) Provide an instrumentation list for each controlled system including all controlled system elements in table format. Tables to show element name, type of device, manufacturer, model number, and product data sheet number.
 - 2) Provide a schematic diagram of each controlled system. Include control points labeled with appropriate point names. Graphically show the location of all control elements.
 - 3) Provide a schematic wiring diagram for each controlled system. Label all elements. Label all terminals.
 - 4) Provide a mounting, wiring, and routing plan-view drawing. Layout to account for HVAC, electrical, and other system design and layout requirements.
 - 5) Provide a complete description of the function of each controlled system including sequence of operation. Provide a complete written sequence of operations for each system or subsystem under all modes of operation. Where Contractor proposes any variation to the sequence of operation described hereunder, the Contractor shall specifically highlight the change and describe the reason for the revision.
 - 6) Provide a points list for each system controller including both input and output (I/O) points. Note point designations, point function, controlled device associated with the I/O point, location of the I/O device, and point alarm

- requirements.
3. Submittals during construction.
 - a. Database information: Four weeks prior to system start-up, provide two copies of complete database information for Engineer's record. Database information will not be reviewed for conformance with Contract Documents. Database information shall include system configuration parameters, point definitions, alarm and trending parameters, control parameters, and control software programs. Specifically document all control functions that cannot be performed by applications specific controllers using pre-programmed control routines or which must be performed by supervisory control from a general-purpose controller.
 - b. Graphics: Provide three copies of all proposed graphics screens for review prior to installation. Allow 2 weeks for review.
 - c. Contractor Verification: Provide Contractor checkout and testing documentation.
 4. Closeout Submittals.
 - a. Submit in accordance with Section 01 78 39 - Project Record Documents.
 - b. Record documents shall include the following:
 - 1) Project record drawings. Project record drawings will be as-built versions of the shop drawings. Include one set of magnetic media including CAD drawings in.DWG format.
 - 2) Provide copy of testing and commissioning reports. Include trend logs used for verification.
 - 3) Material to be included in Project Operation and Maintenance Manuals.
 - a) Names, addresses and 24-hour telephone numbers of installing Contractors and the service representatives for each.
 - b) Operator's manual with procedures for operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
 - c) A listing and documentation of all custom software created using the programming language including set points, tuning parameters, and object database.
 - d) A list of recommended spare parts with part numbers and suppliers.
 - e) Recommended preventive maintenance procedures for all system components including a schedule of tasks, time between tasks, and task descriptions.

1.5 DESIGN REQUIREMENTS

- A. BACnet Compliance.
 1. The BAS shall exchange data between workstations or workstations and building level controllers over the Management Level Network and First-tier BAS Controller Level Network using BACnet Protocol in the form of BACnet objects.
 2. The BAS shall perform network functions using the following BACnet services:
 - a. Alarm and Event.
 - b. Scheduling.
 - c. Trending.
 - d. Network Management.
- B. Performance Standards:
 1. Graphic Display: System shall display a graphic with 20 dynamic points and all current data within 10 seconds.
 2. Graphic Refresh: System shall update a graphic with 20 dynamic points and all current data at no greater than 8 second intervals.
 3. Object Command: The maximum time between an operator command of a binary object and the reaction of the commanded device shall be 2 seconds. The maximum

time between an operator command of an analog object and the start of object adjustment shall be 2 seconds.

4. Object Scan: All changes of state and change of analog values will be transmitted on system communications networks such that any data used or displayed at a controller will have been current within the previous 6 seconds.
5. Alarm Response Time: The maximum time from an object going into alarm-to-alarm annunciation at the workstation shall not exceed 45 seconds.
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Contractor shall select execution times consistent with the process under control.
7. Performance: Programmable controllers shall be able to execute BAS PID control loops at a selectable frequency of a least once per second. The controller shall scan and update the process value and output generated at the same frequency.
8. Multiple Alarm Annunciations: All workstations on the network must receive alarms within 5 seconds of each other.
9. Reporting Accuracy: The system shall report all values with an end-to-end accuracy no less than listed in Table 1.
10. Stability of Control: Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.
- 11.

TABLE 1 - REPORTING ACCURACY		
Measured Variable	Reported Accuracy	
Space Temperature	+1°F	
Ducted Air	+1°F	
Outside Air	+2°F	
Water Temperature	+1°F	
Delta-T	+0.25°F	
Water Flow	+5% of full scale	
Water Pressure	+2% of full scale (see Note 2)	
Electrical (A, V, W, Power Factor)	5% of reading (see Note 3)	
Note 1: 10%-100% of scale		
Note 2: For both absolute and differential pressure		
Note 3: Not including utility-supplied meters		
TABLE 2 - CONTROL STABILITY AND ACCURACY		
Controlled Variable	Control Accuracy	Range of Medium
Space Temperature	+2.0°F	
Duct Temperature	+3.0°F	
Fluid Pressure	+1.5 psi +1.0 in. w.g.	1-150 psi 0-50 in. w.g. differential

1.6 QUALITY ASSURANCE

- A. All products required to conform to BACnet Standards must be BACnet Testing Laboratory (BTL) listed.
- B. All products used in this application, except for those specifically indicated for reuse, shall

be new and under current manufacture and shall be the most recent version offered by the manufacturer for the application. Spare parts shall be available from the manufacturer for at least five years after final completion.

- C. Control Contractor to have in-house, factory-trained and factory-authorized installers and programmers.

1.7 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with all local, state, and federal codes and ordinances including but not limited to the following:
- B. Each DDCP shall be listed under UL916 (Energy Management Systems), UL864-UDTZ (Signal Systems Unit) and shall be tested to comply with sub-part J of Part 15 FCC rules for Class A computing equipment.

1.8 UPDATES

- A. Provide at no extra cost all software and firmware updates that become available from the manufacturer during the warranty period.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Distech, Reliable, Innotech, or approved.

2.2 COMMUNICATIONS

- A. Architecture: Network architecture shall consist of three levels: a management level network, a first-tier controller level, and a second-tier controller level. As an alternative, the management level and first-tier controller levels may be combined into a single level.
 1. Management Level Network:
 - a. The Management Level Network will be used for communications between workstations or workstations and building level controllers.
 - b. The Management Level Network shall reside on industry standard Ethernet physical link using BACnet communications protocol.
 - c. The Management Level Network shall operate at a minimum of 2.5 M baud with full peer-to-peer network communication.
 2. First-tier BAS Controller Level Network:
 - a. The first-tier controller level will be used for communications between Building Controllers or Building Controllers and Advanced Application Controllers.
 - b. The first-tier BAS controller level shall reside on industry standard Ethernet physical link using BACnet communications protocol.
 - c. The first-tier BAS controller level shall operate at a minimum of 2.5 M baud with full peer-to-peer network communication.
 3. Second-tier BAS Controller Level Network:
 - a. The second-tier BAS controller level will be used for communications between Building Level Controllers, Advanced Application Controllers and Application Specific Controllers.
 - b. The second-tier BAS controller level shall be performed using peer-to-peer or MS/TP, LonWorks, or other proprietary communications protocols.
 - c. Second-tier communications shall operate at a minimum speed of 9600 baud.

- B. Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for network communications.
- C. Communications shall provide operator interface and value passing that is transparent to the system architecture as follows:
 - 1. Connection of an operator interface to any controller on the system will allow the operator to interface with all other controllers as if that controller were directly connected. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any controller on the system.
- D. All database values (e.g., objects, software variables, custom programming variables) of any controller shall be readable by any other controller on the system. Value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform system value passing.
- E. The network shall have the following minimum capacity:
 - 1. The first-tier network shall support 50 first-tier controllers.
 - 2. Each first-tier controller shall support 50 second-tier controllers.
 - 3. The entire system shall have the capacity for 12,500 input/output objects associated with first-tier controllers, advanced application controllers, or application specific controllers.

2.3 WORKSTATION GRAPHICS

- A. System Graphics: Provide graphic oriented operator workstation software. System shall display up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for operator to easily move between graphic displays and change the size and location of graphic displays on the screen. System graphics modifiable while online including addition, deletion, or changes to objects on a graphic screen. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall show animation by shifting image files based on object status.
- B. Custom graphic files created by using graphics generator package furnished hereunder. Graphics package shall use mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics package shall also function to capture or convert graphics from other programs such as Designer or AutoCAD.
- C. Graphics Library: Furnish a complete library of standard HVAC equipment graphics including boilers, energy recovery units, water source heat pumps, etc. Library to also include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library provided in file format directly compatible with graphics package.

2.4 SYSTEM APPLICATION SOFTWARE

- A. General: System applications are edited and archived on the PC workstation but executed on the appropriate building controller.
- B. Automatic System Database Save and Restore: Each workstation shall store on the hard drive a copy of the current database of each controller. The database shall update whenever a change is made in any system panel. Storage of the database shall be

automatic and not require operator intervention. The first workstation to detect a database loss, shall automatically restore the database for that controller. Automatic restoration may be disabled by the operator.

- C. Manual Database Save and Restore: Authorized operators able to save the database from any system panel. Operator able to clear a panel database and manually initialize a download of a specified database to any panel on the system.
- D. System Configuration: Workstation software shall provide a method to configure the system to allow for future system changes or additions.
- E. Online Help: Provide a context-sensitive, on-line help system. On-line help available for all applications and shall provide data relevant to screen displayed. Additional help available through use of hypertext.
- F. Security: Each operator shall be required to log on to the system with a username and password to view, edit, add, or delete data whether accessing system from the workstation, portable operator's terminal, or proprietary portable terminal. System security selectable for each operator. System supervisor shall set passwords and security levels for all other operators. Each operator password shall restrict viewing and changing of each system application, editor, and object. Each operator automatically logged off if keyboard or mouse activity is not detected within a user-adjustable time. All security data stored in encrypted form.
- G. System Diagnostics: System shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. Failure of any device shall be annunciated at the workstation.
- H. Alarm Processing: Any object in the system configurable to alarm in and out of normal state. Operator able to configure alarm limits, alarm limit differentials, states, and reactions for each object in the system.
- I. Alarm Messages: Alarm messages shall use English language descriptors allowing the operator to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.
- J. Alarm Reactions: Operator able to set actions to be taken for each alarm. Actions may include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics. Each action configurable by workstation and time of day.
- K. Trend Logs: Operator able to define a custom trend log for any data object in the system. Trend definition shall include interval, start time, and stop time. Trend interval shall be selectable as fixed time or change in value. Trend data sampled and stored on the building controller panel, archived on the workstation hard drive, and retrievable for use in spreadsheets and database programs. System shall be capable of storing 500 sample for each data point.
- L. Alarm and Event Log: Provide chronological alarm and event log. Authorized operator able to view alarm and event log from any location in the system and acknowledge and clear alarms. All alarms that have not been cleared shall be archived to the hard drive on the workstation.
- M. Object and Property Status and Control: Operator able to view and, if required, edit the status of any object and property in the system.

- N. Time clocks in all controllers shall be automatically synchronized daily. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the system. System shall automatically adjust for daylight savings and standard time.
- O. Reports and Logs: Provide a reporting package allowing the operator to select, modify, or create reports. Each report definable for data content, format, interval, and date. Report data archivable on the workstation hard drive for historical reporting. System capable of supplying real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the workstation hard drive in a format readily accessible to other standard software applications, including spreadsheets and word processing. Reports and logs readily sent to the system printer by either operator command or automatically by time-of-day. Standard reports shall include:
1. Objects: All system objects and their current value.
 2. Alarm Summary: All current alarms (except alarms in lockout).
 3. Disable Objects: All objects that are disabled.
 4. Alarm Lockout Objects: All objects in manual or automatic alarm lockout.
 5. Alarm Lockout Objects in Alarm: All objects in alarm lockout that are currently in alarm.
 6. Logs including alarm history, system messages, system events, trends.
- P. Remote Communication: Provide the capability for notifications through network communications in the event of an alarm.
- Q. Standard Application Programs:
1. Sequencing: Provide application software to sequence equipment as required by Section 230929 - BAS Sequence of Operations for HVAC.
 2. PID Control: Provide a proportional-integral-derivative (PID) algorithm with direct or reverse action and anti-windup to perform modulating control of building equipment as required by Section 230929 - BAS Sequence of Operations for HVAC. Algorithm shall calculate a time-varying analog value to position an output or stage a series of outputs. User-selectable controlled variable, setpoint, and PID gains.
 3. Staggered Start: Provide staggered-start application to prevent all controlled equipment from simultaneously restarting after a power outage. User selectable order-of-equipment restart and time delay between starts.
 4. Energy Calculations:
 - a. Provide application to allow instantaneous power or flow rates to be accumulated and converted to energy use data.
 - b. Provide application to calculate a sliding-window average. User selectable window intervals.
 - c. Provide application to calculate a fixed-window average. Initiation of window from digital input signal. User selectable window intervals.
 5. Anti-short Cycling: Provide application to prevent any binary output from short cycling. User selectable minimum on-time and off-time.
 6. On/off Control with Differential: Provide application allowing a binary output to be cycled based on a controlled variable and setpoint. User selectable direct or reverse action and differential setpoint.
 7. Run-time Totalization: Provide application to totalize run-times for all binary input objects.
 8. Time Control Scheduling: Provide application that will start and stop digital and software points according to an adjustable time schedule. Application shall include for basic time schedule, optimum start/stop, special event override, and holiday override.

2.5 WORKSTATION APPLICATION EDITORS

- A. General: Provide Workstation Application Editors to edit all applications that reside at system controllers. Applications shall be downloaded and executed at one or more of the controller panels.
- B. Controllers: Provide a full-screen editor for each type of application allowing the operator to view and change the configuration, name, control parameters, and setpoints for all controllers.
- C. Scheduling: Provide an editor for the scheduling application. Provide a monthly and weekly calendar for each schedule where scheduling parameters can be changed. Provide a method allowing several objects to follow a schedule with start and stop times for each object adjustable from a master schedule. Schedules shall be easy to copy to other objects and dates.
- D. Custom Application Programming: Provide the tools to create, modify, and debug custom application programming. Program creation, modification, or downloading allowed while all other system applications are operating. The programming language shall provide the following features:
 - 1. Provide English language orientation based on BASIC, FORTRAN, C, or PASCAL. Language shall allow free-form programming, i.e., not column-oriented or "fill in the blanks". Alternately, the programming language can be graphically based using function blocks if blocks are available to directly provide the functions listed below and custom or compound function blocks can be created.
 - 2. Provide a full-screen character editor. Editor shall be cursor/mouse-driven allowing the user to insert, add, modify, and delete custom programming code. Editor shall also support word processing features such as cut/paste and find/replace.
 - 3. Allow development of independently executing program modules with each module able to independently enable or disable other modules.
 - 4. Provide debugging/simulation capability allowing users to step through the program and observe intermediate values and results. Debugger shall provide error messages for syntax and execution errors.
 - 5. Support conditional statements (IF/THEN/ELSE/ELSE-IF) and relations comparisons (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL).
 - 6. Support floating-point arithmetic using operators including plus, minus, divide, times, and square root. The language shall also provide absolute value and minimum/maximum value from a list of values.
 - 7. Provide pre-defined variables representing time of day, day of the week, month of the year, and date. Provide additional variables including elapsed time in seconds, minutes, hours, and days. Elapsed time variable may be reset so that interval-timing functions can be stopped and started within a program. Values from above variables readable so that they can be used in a program for IF/THEN comparisons, calculations, etc.
 - 8. Programming language shall have pre-defined variables representing the status and results of Controller Software and shall be able to enable, disable, and change the setpoints of Controller Software.

2.6 SYSTEM CONTROLLERS

- A. First-tier Controllers (Building Controllers): Independent, stand-alone, microprocessor-based controller to manage global control and communication. Provide the number of first-tier controllers needed to meet specified performance requirements. As a minimum, provide one first-tier controller per building. Controllers shall have the following general characteristics. BTL Listed.
1. Sufficient memory in each controller to support its operating system, database, and programming requirements including specified spare capacity.
 2. Controller operating system to manage input and output communications allowing distributed controllers to share real and virtual object information and allow central monitoring and alarms.
 3. Controller shall continually check the status of its processor and memory circuits. If an abnormal condition is detected, the controller shall assume a pre-determined failure mode, and generate an alarm notification.
 4. Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
 5. Controller shall include a service communication port allowing connection to a portable operator's terminal.
- B. Advanced Application Controllers: Independent, stand-alone, microprocessor-based controller to provide local control of systems and equipment requiring advanced program sequences. Provide the number of advanced application controllers needed to meet specified performance requirements. Controllers shall have the following general characteristics. BTL Listed.
1. Sufficient memory in each controller to support its operating system, database, and programming requirements including specified spare capacity.
 2. Controller operating system to manage input and output communications allowing distributed controllers to share real and virtual object information and allow central monitoring and alarms.
 3. Controller shall continually check the status of its processor and memory circuits. If an abnormal condition is detected, the controller shall assume a pre-determined failure mode, and generate an alarm notification.
 4. Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
 5. Controller shall include a service communication port allowing connection to a portable operator's terminal.
- C. Application Specific Controllers: Independent, stand-alone microprocessor-based controller to control local equipment or systems where the associated sequence of operation can be met using pre-programmed control routines. Controllers should have the following general characteristics:
1. Sufficient memory in each controller to control the target system.
 2. Non-volatile memory to maintain the BIOS and programming information in the event of a power failure.
- D. Controller hardware suitable for the anticipated ambient conditions.
1. Controllers used in conditioned space mounted in dust-proof enclosures and rated for operation at 32 degrees F to 120 degrees F.
- E. Provide diagnostic LEDs for power, communication, and processor. All wiring connections made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
- F. All controllers shall operate at 90% to 110% of nominal voltage and perform an orderly shutdown below 80% nominal voltage. Operation protected against electrical noise at 5 to

120 Hz and from keyed radios up to 5 W at 3 feet.

2.7 INPUT/OUTPUT INTERFACE

- A. Hardwire inputs and outputs may connect to the system through a first-tier, advanced application, or application specific controller.
- B. All input and output points protected so that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points protected from connected voltage up to 24V of any duration.
- C. Binary Inputs: Binary controller inputs shall provide a wetting current of at least 12 mA and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power application required.
- D. Pulse Accumulation Inputs: In addition to standard binary input characteristics, pulse accumulation inputs shall accept up to 10 pulses per second.
- E. Analog Inputs: Analog inputs shall allow the monitoring of low voltage (0 to 10VDC), current (4 to 20 mA), or resistance signals (thermistor or RTD). Analog inputs compatible with commonly available sensing devices.
- F. Binary Outputs: Binary outputs to provide on/off control or a pulsed low-voltage signal for pulse-width modulation. Provide three-position (on/off/auto) switch for each output along with indicator light. Output selectable for normally open or normally closed operation.
- G. Analog Outputs: Analog outputs to provide a modulating 0 to 10V or 4 to 20 mA signal for control of an end device. Provide two-position (auto/manual) switch, status lights, and manually adjustable potentiometer for each output. Analog output drift less than 0.4% of range per year.
- H. Tri-state Outputs: Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point actuators limited to terminal unit and unit ventilator control applications. Control algorithms shall send the actuator to one end of its stroke every 24 hours for verification of operator tracking.

2.8 POWER SUPPLIES AND LINE FILTERING

- A. Provide UL listed control transformers. Provide class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
- B. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge suppression shall have the following minimum performance criteria:
 - 1. Dielectric strength of 1000 volts minimum.
 - 2. Response time of 10 nanoseconds.
 - 3. Transverse mode noise attenuation of 65 dB or greater.
 - 4. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.
- C. Uninterrupted Power Supplies: Provide uninterrupted power supply (UPS) for all control devices furnished under this project to maintain all control systems fully operational for a period of 24 hours in the event of a power outage. Contractor responsible for sizing UPS to meet power demands of supplied equipment. UPS equipped with a digital alarm output

which activates when equipment has malfunctioned or battery failure.

2.9 WEB INTERFACE

- A. General:
 - 1. BAS supplier shall provide web-based access to the system via connection to Owner's Ethernet network connection.
 - 2. Contractor shall provide all communication media, connectors, repeaters, servers, hubs, and routers necessary for network connection. Coordinate with Owner data/telecom staff.
 - 3. System shall allow simultaneous web interface by up to five independent users without additional licensing or upgrades to hardware or software provided hereunder.
 - 4. User shall not require installation of software on non-workstation computers beyond a current Chrome browser.
- B. Architecture: System may provide web interface through workstation, independent stand-alone Web host, or building controller.
- C. Capabilities:
 - 1. System graphics: Provide navigation capability through all system graphics. Provide real time data display of all system point values.
 - 2. View trend graphics: Provide trend information via graphical display. User shall be able to select points to be viewed and set time period and display interval.
 - 3. Alarms: Users shall be able to receive, acknowledge, and silence alarms.
 - 4. Event Log: Users shall be able to view event log.
 - 5. Scheduling: Users shall be able to view and modify equipment operating schedules.
- D. Security: Access via the Web browser shall use the same hierarchical security scheme as the BAS. User shall be asked to log in once the browser makes connection to the system, and activity will be limited to those allowed by security limits. After log-in, the system shall record all activity on the event log. Systems shall monitor unsuccessful login attempts. If unsuccessful login attempts exceed owner defined setpoint send alarm message to alarm log and turn off WEB server.
- E. Data Export: The system shall be capable of automatically transmitting energy use records to a remote web host provided by the Owner. Data shall be in the form of comma delimited files or other format that can be used to produce energy reports accessible to remote users via web interface.

2.10 WIRING AND RACEWAYS

- A. Provide wiring, plenum cable, and raceways in accordance with Division 26.
- B. All insulated wire to have copper conductor. UL labeled for 90 degree C service.

PART 3 EXECUTION

3.1 COORDINATION

- A. Testing and Balancing.
 - 1. Provide to the Testing and Balancing Contractor a set of all tools and temporary licenses necessary to interface to the control system for testing and balancing purposes. Tools to be returned at the completion of test and balancing work.
 - 2. Provide training in the use of the tools.

3. Provide a qualified technician to assist in the testing and balancing process where required.
- B. Coordinate with controls specified in other sections or divisions. Other sections or divisions include controls and control devices to be part of or interfaced with the control system specified in this section. Integration and coordination with these controls shall be as follows:
1. All communications media and equipment required to interface with equipment specified in other sections provided hereunder unless specifically stated otherwise.
 2. Each supplier of a control product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequence of operation stated in Section 230929 - BAS Sequence of Operations for HVAC.
 3. Coordinate and resolve any compatibility issues arising between control products provided hereunder and those provided under other sections or divisions.

3.2 WORKMANSHIP

- A. Install all equipment in accordance with manufacturers' recommendations.
- B. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
- C. Provide sufficient slack and flexible connections in wiring to allow for vibration of piping and equipment.
- D. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electric Code.

3.3 EXISTING EQUIPMENT

- A. Existing Wiring: Contractor may reuse existing wiring provided the quality of the existing installation meets this specification. Verify the integrity of existing wiring or tubing and re-label in accordance with this specification. Remove wiring abandoned as the result of this work.
- B. Local Control Panels: Contractor may reuse existing control cabinets to locate new equipment where existing cabinets are in good condition. Remove all redundant equipment within these cabinets. Patch face cover to fill all holes caused by removal of unused equipment.
- C. Unless specifically stated elsewhere, Contractor is not responsible for the repair or replacement of existing control system equipment to be reused. Such equipment includes but is not limited to control devices, valves, dampers, or actuators. Should the Contractor find existing equipment requiring maintenance, Contractor shall notify the Owner immediately. Repair will be performed under separate Contract.
- D. Temperature Sensor Wells: Contractor may reuse existing sensor wells in piping. Modify wells as required to provide proper fit of sensors.
- E. Starters: Modify existing starter control circuits, in necessary, to provide hand/off/auto control of each starter controlled. Provide new starters or starter control package if required.

3.4 ELECTRICAL POWER

- A. Power Connections:
 - 1. Connect electrical power to system products requiring electrical power connections from the normal power system, except where otherwise required. Refer to 23 09 29 - BAS Sequence of Operations for HVAC and Plumbing.

3.5 GENERAL WIRING

- A. All control and interlock wiring shall comply with national and electrical codes and Division 26. Where requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.
- B. Provide circuits for controls power as required. Coordinate with Division 26 for provision of power. and See Division 26 for circuits included in project design.
- C. All line voltage wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
- D. All low-voltage wiring shall meet NEC Class 1 or Class 2 requirements. Low voltage power circuits shall be sub-fused when required.
- E. Where NEC Class 1 and Class 2 wires are in concealed and accessible locations, including ceiling plenum return air plenums, approved cable not in raceway may be used provided cables are UL listed for the intended application.
- F. All wiring in mechanical, electrical, or service rooms and wiring located where it may be subject to damage shall be installed in raceway.
- G. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring may not be used for low-voltage wiring except for the purpose of interfacing the two.
- H. Where Class 2 wiring is installed exposed, wiring is to be routed parallel or perpendicular to building lines and neatly tied at a maximum of 10-foot intervals.
- I. Where plenum cables are used without raceway, support or anchor cable from building structure. Do not anchor or support cable from ductwork, electrical raceways, piping, or suspended ceiling systems.
- J. Provide all wire-to-device connections at terminal block or terminal strip. Provide all wire-to-wire connections at terminal block.
- K. Neatly bundle wiring located within enclosures to permit access to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, Contractor shall provide a step-down transformer.
- M. All wiring shall be installed as continuous lengths with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Provide firestop foam where necessary to maintain fire rating.
- O. Provide size of raceway and size and type of wire as required by NEC and as required to

meet manufacturers' recommendations for connected equipment.

- P. Include one pull string in each raceway 1-inch or larger.
- Q. Use color coded conductors throughout.
- R. Locate control and status relays in designated enclosures only. Such enclosures include packaged equipment control cabinets unless such cabinets also contain Class 1 starters.
- S. Conceal all raceways except within mechanical, electrical, or service rooms. Maintain minimum raceway clearance of 6-inches from high temperature equipment such as steam piping or boiler flues.
- T. Secure raceways with raceway clamps fastened to the structure and spaced in accordance with code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be supported from ductwork, electrical raceways, piping, or suspended ceiling systems.
- U. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all raceways.
- V. Maintain updated wiring diagrams (as built) at site with terminations identified.
- W. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3-feet in length and shall be supported at both ends. Flexible metal raceway less than ½-inch electrical trade size shall not be used. In areas exposed to moisture, including but not limited to chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

3.6 COMMUNICATION WIRING

- A. Install in accordance with 3.03 above.
- B. Follow manufacturers' recommendations for all communications cabling including but not limited to maximum pulling, tension, and bend radius.
- C. Do not install communications cabling in a raceway or enclosure containing Class 1 or other Class 2 wiring.
- D. Verify the integrity of the entire network immediately following cable installation using test measures appropriate for each cable.
- E. Provide a lightning arrestor between cables and grounds where cable enters or exits a building. Install arrestor in accordance with manufacturers' recommendations.
- F. All communications wiring shall be un-spliced length when that length is commercially available.
- G. All communications wiring shall be labeled to indicate origination and destination.
- H. Ground coaxial cable in accordance with NEC regulations article on "Communications Circuits, Cable and Protector Grounding."

3.7 IDENTIFICATION OF HARDWARE AND WIRING

- A. Label all wiring and cabling, including wiring and cabling terminating within factory-

fabricated panels, within 2 inches of termination with the BAS address or termination number.

- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum ½-inch letters on laminated plastic nameplate.
- D. Identify all other control components with permanent labels. All plug-in components shall be labeled so that removal of component does not remove label.
- E. Identify room sensors relating to terminal box or valves with nameplate located within sensor cover.
- F. Arrange components so that UL or CSA labels are visible after equipment is installed.
- G. Identifiers shall match record documents.
- H. Provide laminated network communication diagrams, point-to-point wiring diagrams, and process control diagrams in each control panel for control components contained therein.

3.8 BAS CONTROLLER INSTALLATION

- A. Provide a separate BAS controller for each air handling unit or other discrete system. A BAS controller may control more than one system provided that all points associated with the system are assigned to the same BAS controller. Points used for control loop reset, such as outside air temperature or space temperature, are exempt from this requirement.
- B. Building Controllers and Advanced Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type. If input points are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.
 - 1. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of spare points.
- C. Provide sufficient internal memory for the specified sequences of operation and trend logging. Provide a minimum of 25% available memory free for future use.

3.9 PROGRAMMING

- A. Provide programming for the system as required to perform the sequence of operation. See Section 230929 - BAS Sequence of Operations for HVAC. Provide all other programming necessary for proper operation of the system but not specified including but not limited to time delays, control deadbands, equipment interlocks, equipment sequencing, alarm notification, and control sequences recommended by equipment manufacturers.
- B. All control setpoints and loop tuning parameters accessible for review and adjustment at workstation graphics or through workstation menus without requiring modification of program code.
- C. For systems using text-based programming, imbed comments in the programming code to clearly describe each section of the program.

- D. Contractor to provide time scheduling functions as specified in the Sequence of Operations. Independent schedules shall be provided for each system, unless otherwise specified.
- E. Contractor to provide alarming functions as specified in the Sequence of Operations. Contractor shall also configure alarming functions as directed by Owner including setting alarm limits and differentials, states, type of notification, and alarm messages.
- F. Contractor shall configure trending functions as directed by Owner including trend data collection and report format.
- G. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. Point naming convention as follows.
 1. AA.BBB.CCDDE where.
 - a. AA designates the location of the point within the building, such as a mechanical room, wing, level, or the building itself in a multi-building environment.
 - b. BBB designates the system which the point is associated. (e.g., A01 for air handler 1, HTG for heating water system, etc.).
 - c. CC designates the equipment or material referenced within the system. (e.g., SF for supply fan, HR for heating water return, etc.).
 - d. D or DD used for clarification or for identification if more than one CC exists.
 - e. E designates the action or state of the equipment or medium. (e.g., T for temperature, H for humidity, C for control, S for status, D for damper control, etc.).
- H. Configure three usernames with differing levels of privileges. Meet with Owner's Authorized Representative and coordinate access levels and privileges for each uses access.

3.10 GRAPHICS

- A. Provide graphics for all controlled systems and floor plans of the building. As a minimum, systems requiring graphics to include each water system, heat recovery unit, and all terminal equipment. Point information on the graphic displays shall dynamically update. On each graphic, show input and output points for the system. Also, show relevant calculated points such as setpoints. Input, output, and software point values shall be changeable from graphic screen. Provide link to a text file containing the automatic control sequence of operations.
- B. Meet with Owners Authorized Representative prior to beginning development of graphic displays to discuss Owner's preferences.
- C. Show heat pump unit information on a "graphic" summary table. Provide dynamic information on each point shown.

3.11 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Contractor shall completely test and verify specified control system performance. Compile test results and include with written certification.
- B. Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all instruments, controls, and accessory equipment furnished hereunder.
- C. Contractor shall perform the following testing and verification:
 1. Verify that all control and communications wiring is properly connected and free of all

- shorts and ground faults. Verify that terminations are tight.
2. Enable control systems and verify instrument calibration and end-to-end reporting accuracy of all input devices individually. Perform calibration in accordance with manufacturers' recommendations. Repair or replace all temperature sensors requiring a calibration offset greater than +/- 1°F.
 3. Verify control stability and end-to-end reporting requirements are met.
 4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that normal positions are correct.
 5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, start/stop and span are correct, and direction and normal position are correct.
 6. Verify that system operation complies with the sequence of operations. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all BAS control loops and optimum start/stop routines.
 7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Trip interlocks using field contacts to check the logic and ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Test interlock actions by simulating alarm conditions to check the initiating value of the variable and the interlock action.
- D. Contractor shall maintain the following documentation:
1. Calibration log including date, time, control system readout, means of verification, verification measurement, and required calibration offset for each analog input.
 2. BAS Loop Response: Supply trend data output in graphical form showing the step response of each BAS loop. The test shall show the loop's response to a change in set-point requiring a change in actuator position of at least 25% of full range. Provide sampling rate from 10 seconds to 1 minute depending on loop speed. Trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Contractor shall retune any loop that indicates unreasonably under-damped or over-damped control.
 3. Demand Limiting: Supply trend data showing the action of any demand limiting functions. Document operation at maximum one-minute intervals for at least 30 minutes.
 4. Operational Logs: Provide operational trend logs for each system indicating setpoints, operating points, valve positions, mode, and equipment status. Logs shall cover three 48-hour periods and have a sample frequency of not more than 5 minutes. Logs provided in both printed and disk formats.
- E. After system operation is completely verified, provide written certification to Owner that systems have been fully tested and are operating according to specifications and ready for functional testing. Provide copies of documentation signed by person performing tests. Documentation to include:
1. Calibration logs.
 2. BAS Loop Response Trends.
 3. Demand Limiting Trends.
 4. Operational Logs.

3.12 DEMONSTRATION AND ACCEPTANCE

- A. Demonstrate operation of control system to Owner and Engineer including:
1. Menu functions.
 2. Point overrides.
 3. Control loop response after point modification.
 4. Alarm response time.

3.13 TRAINING

- A. Provide a minimum of 24 hours training to Owner's personnel in use and maintenance of BAS building management and control hardware and software. Training shall be provided in two (2) sessions of 8 hours each and two (2) sessions of 4 hours each as follows:
 - 1. The first session shall provide system overview and training on log on procedures, data access and display, alarm and status descriptions, log requests, execution of commands, and other general system operation procedures.
 - 2. The second session shall include instruction on system maintenance procedures. Procedures reviewed will include day-to-day system maintenance requirements, calibration techniques and diagnosis of system failures. Diagnosis procedures shall include instructions to follow in the event of failure of each control sub-system or device.
 - 3. Two remaining sessions shall include instruction on site-specific programs, graphics, and user interfaces.
- B. Manufacturers Training: Provide 24-hour manufacturer training course for 3 Owner's Representatives. Training shall be provided on a variety of topic as selected by the Owner. Training shall be performed at manufacturer's designated locations.

3.14 POINTS LIST

- A. As specified and as scheduled on drawings.

END OF SECTION

SECTION 230925

BAS FIELD-MOUNTED DEVICES FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Temperature instruments.
 - 2. Pressure Instruments.
 - 3. Electrical Instruments.
 - 4. Control Valves.
 - 5. Damper Actuators.
- B. Related Requirements:
 - 1. Section 230923 - Building Automation Systems.
 - 2. Section 230929 - Building Automation System Sequence of Operations.

1.2 DEFINITIONS

- A. BAS: Building Automation System.
- B. Cv: Design valve coefficient.
- C. HART: Highway Addressable Remote Transducer Protocol.
- D. NBR: Nitrile butadiene rubber.
- E. PTFE: Polytetrafluoroethylene.
- F. RTD: Resistance temperature detector.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 3. Product description with complete technical data, performance curves, and product specification sheets.
 - 4. Installation operation and maintenance instructions, including factors affecting performance.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.
4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each product requiring a certificate.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. BAS Configuration Data: Provide configuration data necessary for programming conversion of analog output signals to accurately indicate measured values. Calibration data shall be specific to the measurement device installed.
- D. Field quality-control reports.
- E. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Control valve installation location shown in relationship to room, duct, pipe, and equipment.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 1. BAS Configuration Data: Copy of analog input configuration data using for programming BAS.
 2. Control Valves: Operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- D. Backup Power Source: Systems and equipment served by a backup power source shall have associated instruments and control valve actuators served from a backup power source.

- E. Environmental Conditions:
1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:
 - a. Indoors, Heated with Filtered Ventilation: Type 1.
 - b. Indoors, Heated with Non-Filtered Ventilation: Type 2.
 - c. Mechanical Equipment Rooms:
 - 1) Mechanical Rooms: Type 12.
 - d. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 12.
 - e. Hazardous Locations: Explosion-proof rating for condition.
- F. Control Valve Selection Criteria:
1. Control valves shall be suitable for operation at following conditions:
 - a. Condenser Water: 175 psi maximum working pressure and 220 degree F, except where otherwise indicated.
 2. Shutoff Characteristics: Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.
 3. Configuration and Flow Characteristics:
 - a. Valve pattern, three-way or straight through, shall be as indicated on Drawings.
 - b. Modulating butterfly valves shall have equal percentage flow-throttling characteristics, except where otherwise indicated.
 4. Valve Sizing.
 - a. Water systems, modulating:
 - 1) Select valves at air handler coils and heat exchangers for a design Cv based on a pressure drop of 3 to 5 psig at design flow unless otherwise indicated.
 - b. Two-position control valves: line size unless otherwise indicated.
 5. Fail positions unless otherwise indicated:
 - a. Condenser Water: Close.
 6. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
 - a. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
 7. Selection shall consider viscosity, flashing, and cavitation corrections.

2.2 TEMPERATURE SENSORS, TRANSMITTERS, AND SWITCHES

- A. Liquid Temperature Transmitters, Commercial Grade.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Building Automation Products, Inc. (BAPI).
 - b. Greystone Energy Inc.
 - c. Schneider Electric.
 - d. Vaisala.
 - e. Veris Industries.
 - f. Approved BAS System Manufacturer.
 2. House electronics in NEMA 250, Type 4 or Type 4X enclosure.
 3. Functional Characteristics:
 - a. Input: 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two- or three-wire sensors.

- b. Default Span (Adjustable):
 - 1) Chilled Water: Zero to 100 deg F.
 - 2) Condenser Water: Zero to 120 deg F.
 - 3) Heating Hot Water: 32 to 212 deg F.
 - 4) Heat Recovery: Zero to 120 deg F.
 - 5) Low Pressure Steam: 40 to 260 deg F.
 - c. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
 - d. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
 - e. Match sensor with temperature transmitter and factory calibrate together. Each matched sensor and transmitter set shall include factory calibration data traceable to NIST.
4. Performance Characteristics:
- a. Calibration Accuracy: Within 0.1 percent of the span.
 - b. Stability: Within 0.2 percent of the span for at least 6 months.
 - c. Combined Accuracy: Within 0.5 percent.

2.3 PRESSURE SENSORS, TRANSMITTERS, AND SWITCHES

A. Liquid Pressure Transmitters.

1. Liquid-Pressure Differential Transmitter, Commercial Grade:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dwyer Instruments, Inc.
 - 2) Greystone Energy Inc.
 - 3) Schneider Electric.
 - 4) Setra Systems, Inc.
 - 5) Veris Industries.
 - b. Performance:
 - 1) Range: Approximately 2 times the set point.
 - 2) Span: Adjustable plus or minus one milliamp, noninteractive.
 - 3) Accuracy: Within 0.25 percent of full scale.
 - 4) Hysteresis: Within 0.1 percent of full scale.
 - 5) Repeatability: Within 0.05 percent of full scale.
 - 6) Maximum Working Pressure: 250 psig.
 - 7) Temperature Limits: Zero to 175 deg F.
 - 8) Compensate Temperature Limits: 30 to 150 deg F.
 - 9) Thermal Effects: 0.02 percent of full scale per degree F.
 - 10) Response Time: 30 to 50 ms.
 - 11) Shock and vibration shall not harm the transmitter.
 - c. Analog Output Current Signal:
 - 1) Two-wire, 4- to 20-mA dc current source.
 - 2) Signal capable of operating into 1000-ohm load.
 - d. Operator Interface:
 - 1) Zero and span adjustments located behind cover.
 - 2) Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.
 - e. Construction:
 - 1) Aluminum and stainless-steel enclosure with removable cover.
 - 2) Wetted parts of transmitter constructed of 17-4 PH or 300 Series stainless steel.
 - 3) NEMA 250, Type 4.
 - 4) Piping Connections:
 - a) Remote pressure transducers with threaded, NPS 1/4 process connections/

- f. Basis of Design: Setra's "Model 231RS.

2.4 ELECTRICAL SWITCHES, RELAYS, SENSORS AND TRANSMITTERS

A. Switches and Relays.

1. Push Buttons, Position Selector Switches, Manual Operating Switches.
 - a. General: UL listed, industrial grade.
2. Single Phase Motor Control Relay.
 - a. Acceptable Manufacturer: Greenheck, Veris,
 - b. General: Industrial grade load-switching relay, current status switch, and Hand-Off-Auto switch for control or fractional horsepower single phase motors. The relay, current sensor, and HOA switch are combined in a series circuit. Once an H5xx is wired in series between the power source and motor, all three components are installed.
 - c. Relay: Contacts rated for connected motor load, SPST relay is field-selectable for N.O. or N.C. operation. LED status indicator light.
 - d. Current Status Switch: Adjustable setpoint.
 - e. Housing: Surface mounted. The housing provides physical separation and multiple wiring exits to isolate control and high voltage wiring.
 - f. Similar to Veris, Hawkeye Model 500 Series.

B. Electrical Current Switches.

1. Current Status Switches, Fixed Trip.
 - a. Acceptable Manufacturer: Hawkeye or approved equal.
 - b. General: Fixed trip point current switch.
 - c. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from .25 A to 200 A.
 - d. Normally open current sensor output. 0.1A at 30 VAC/DC.
 - e. Similar to Hawkeye Model H800.
2. Current Status Switches for Constant Load Devices, Adjustable Trip.
 - a. Acceptable Manufacturer: Hawkeye or approved equal.
 - b. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
 - c. Visual LED indicator for status.
 - d. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 2.5 A to 135 A.
 - e. Normally open current sensor output. 0.1A at 30 VAC/DC.
 - f. Similar to Hawkeye Model 908.
3. Current Status Switches for Variable Frequency Drive Application, Adjustable Trip.
 - a. Acceptable Manufacturer: Hawkeye or approved equal.
 - b. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on variable loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
 - c. Visual LED indicator for status.
 - d. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 5 A to 135 A and from 5 to 75 Hz.
 - e. Normally open current sensor output. 0.1A at 30 VAC/DC.
 - f. Similar to Hawkeye Model H904.

C. Electrical Current Transmitters.

1. Electrical Current Transmitter:
 - a. Acceptable Manufacturer: Veris.
 - b. General: Split-core CTs with the electronics embedded inside CT. The transducer

- shall measure amperage.
- c. Maximum Amperage: 125% to 200% of rated equipment amperage.
- d. Output: 4 to 20 mA or 0-10 vdc.
- e. Performance:
- f. Accuracy: +/- 2% from of the rated current over a temperature range of 0-60° C.
- g. Ratings: Transmitter internally isolated to 600 VAC.
- h. Basis of Design: Similar to Hawkeye H923 series.

2.5 CONTROL VALVES

- A. Butterfly Control Valves.
 - 1. Commercial-Grade, Two-Way or Three-Way:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Belimo, Inc.
 - 2) Johnson Controls, Inc.
 - 3) Keystone; Emerson Electric Co.
 - 4) Siemens Industry, Inc., Building Technologies Division.
 - b. Three-Way Arrangement: Two, 2-way valves mated to a fabricated tee with interconnecting mechanical linkage.
 - c. Performance:
 - 1) Bi-directional bubble tight shutoff at 200 psig.
 - 2) Rotation: Zero to 90 degrees.
 - 3) Linear or modified equal percentage flow characteristic.
 - d. ASME B16.34, Class 150.
 - e. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
 - f. Disc: 316 stainless steel.
 - g. Shaft: 316 or 17-4 PH stainless steel.
 - h. Seat: Reinforced EPDM or reinforced PTFE seat with retaining ring.
 - i. Shaft Bushings: Reinforced PTFE or stainless steel.
 - j. Replaceable seat, disc, and shaft bushings.
 - k. Corrosion-resistant nameplate indicating:
 - 1) Manufacturer's name, model number, and serial number.
 - 2) Body size.
 - 3) Body and trim materials.
 - 4) Flow arrow.

2.6 CONTROL VALVE AND DAMPER ACUATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belimo, Inc.
 - 2. Honeywell International, Inc.
 - 3. Johnson Controls, Inc.
 - 4. Siemens Industry, Inc., Building Technologies Division.
- B. Performance.
 - 1. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
 - 2. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.
 - 3. Actuators for Control Dampers: Capable of closing valve against system fan maximum static pressure that can be developed by fan.
 - 4. Actuator operating speed shall provide response required for the intended control

- function and be compatible with equipment and system operation.
5. Maximum sound level: 65 dBa.
- C. Type: Motor operated, with or without gears, electric and electronic.
- D. Voltage: Voltage selection delegated to professional designing control system, unless otherwise indicated.
- E. Position indicator and graduated scale on each actuator.
- F. Construction:
1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
 2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
 3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
- G. Field Adjustment:
1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
 2. Gear Type Actuators:
 - a. External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
 - b. Adjustable mechanical end stops.
- H. Modulating Actuators:
1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
 2. Control Input Signal:
 - a. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.
 - b. Programmable Multi-Function:
 - 1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
 - 2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
 - 3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
- I. Fail-Safe:
1. Where indicated, provide actuator to fail to an end position.
 2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
 3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.
- J. Integral Overload Protection:
1. Provide against overload throughout the entire operating range in both directions.
 2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

- K. Valve Attachment:
 1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
 2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
 3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

- L. Temperature and Humidity:
 1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.

- M. Enclosure:
 1. Suitable for ambient conditions encountered by application.
 2. NEMA 250, Type 2 for indoor and protected applications.
 3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
 4. Provide actuator enclosure with heater and control where required by application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation. Verify that the proposed mounting locations comply with manufacturers recommendations and requirements indicated and approved submittals.

- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation. Verify that the proposed mounting locations comply with manufacturers recommendations and requirements indicated and approved submittals.

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

3.2 APPLICATION

- A. Temperature Instruments.
 1. Air Temperature Sensors and Transmitters:
 - a. Outdoor: Air Temperature Transmitter.
 - b. Space: Air Thermistor Sensor.
 2. Liquid Temperature Sensors and Transmitters:
 - a. Condenser Water Systems (below 100°F): Liquid Temperature Transmitter, Commercial Grade.

- B. Pressure Instruments.
 1. Liquid-Pressure Differential Transmitters:
 - a. Condenser Water System, Differential Pressure Control: Liquid-pressure Differential Transmitter, Commercial Grade.

- C. Electrical Instruments.
 1. Motor Operating Status:
 - a. Motors ½ hp and larger, constant speed: Current Status Switches, Fixed Trip or Current Status Switches for Constant Load Devices, Adjustable Trip

- b. Motors ½ hp and larger, variable speed: Current Status Switches for Variable Frequency Drive Application, except where motor status can be obtained from VFD or ECM motor control.
 - c. Motors ½ hp and larger, variable speed: Electrical Current Transmitters, except where motor status can be obtained from VFD or ECM motor control.
- D. Control Valves.
- 1. Select from valves specified in "Performance Requirements, Control Valve Selection Criteria" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
 - 2. Control valves shall be two-way or three-way commercial-grade.
 - 3. Butterfly Control Valves, Two-way or Three-way: Commercial-grade.
 - a. Modulating water serve 2-1/2 inches and large.

3.3 INSTALLATION

- A. General.
- 1. Install products level, plumb, parallel, and perpendicular with building construction.
 - 2. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.
 - 3. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
 - 4. Fastening Hardware:
 - a. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - b. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 5. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
 - 6. Corrosive Environments:
 - a. Use products that are suitable for environment to which they are subjected.
 - b. If possible, avoid or limit use of materials in corrosive environments. Do not materials included transmitters, valves and actuators in the following locations unless specifically shown on drawings:
 - 1) Laboratory exhaust airstreams.
 - 2) Process exhaust airstreams.
 - c. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
 - d. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.
 - 7. Mounting Height:
 - a. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
 - b. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements at 60 inches above the adjacent floor, grade, or service catwalk or platform.

8. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class.

B. Temperature Instruments.

1. Mounting Location:
 - a. Roughing In:
 - 1) Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
 - 2) Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
 - a) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
 - b) Do not begin installation without submittal approval of mounting location.
 - 3) Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner's Authorized Representative.
 - b. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
 - c. Install temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings or approved by the Owner's Authorized Representative.
 - d. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
2. Special Mounting Requirements:
 - a. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
 - b. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.
3. Space Temperature Sensor Installation:
 - a. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
 - b. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
 - c. In finished areas, recess electrical box within wall.
 - d. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
 - e. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.
4. Outdoor Air Temperature Sensor Installation:
 - a. Mount sensor in a discrete location facing north.
 - b. Protect installed sensor from solar radiation and other influences that could impact performance.
5. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.
6. Single-Point Duct Temperature Sensor Installation:
 - a. Install single-point-type, duct-mounted, supply- and return-air temperature

sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches in sensor length.

- b. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
 - c. Rigidly support sensor to duct and seal penetration airtight.
 - d. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.
7. Liquid Temperature Sensor Installation:
- a. Assembly shall include sensor, thermowell.
 - b. For pipe NPS 4 and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
 - c. For pipe smaller than NPS 4:
 - 1) Install reducers to increase pipe size to NPS 4 at point of thermowell installation.
 - 2) For pipe sizes NPS 2-1/2 and NPS 3, thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
 - 3) Minimum insertion depth shall be 2-1/2 inches.
 - d. Install matching thermowell.
 - e. Fill thermowell with heat-transfer fluid before inserting sensor.
 - f. Tip of spring-loaded sensors shall contact inside of thermowell.
 - g. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
 - h. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
 - i. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor, service platform, or catwalk.

C. Pressure Instruments.

1. Mounting Location:

- a. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
- b. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
- c. Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
- d. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
- e. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- f. Install instruments (except pressure gages) in steam, liquid, and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
- g. Install instruments in dry gas and non-condensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

- D. Control Valves.
 - 1. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.
 - a. Install flanges or unions to allow drop-in and -out valve installation.
 - 2. Valve Orientation:
 - a. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
 - b. Install valves in a position to allow full stem movement.
 - c. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.
 - d. Three-way control valve shall be installed in accordance with manufacturers recommendations and with supply and bypass ports connect in accordance with manufacturers installation instructions. If valve connections do not correspond with details shown on the drawings, notify engineer prior to installation. Do not install control valves without written direction from the Engineer.
 - 3. Clearance:
 - a. Locate valves for easy access.
 - b. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

3.4 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 - Enclosed Switches and Circuit Breakers.
- C. Furnish and install power wiring. Comply with requirements in 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- D. Furnish and install raceways. Comply with requirements in 26 05 33 - Raceways and Boxes for Electrical Systems.

3.5 IDENTIFICATION

- A. Identify control components and piping. Comply with 23 05 53 - Identification for VAC Piping and Equipment.
- B. Identify system electrical components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 - Identification for Electrical Systems.

3.6 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.7 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Description:
 - 1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

2. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
3. Provide diagnostic and test equipment for calibration and adjustment.
4. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
5. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
6. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
7. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

END OF SECTION

SECTION 230929

BAS SEQUENCE OF OPERATIONS FOR HVAC AND PLUMBING

PART 1 GENERAL

1.1 SUMMARY

- A. Provide custom engineered BAS operating software to perform control sequences specified.
 - 1. Systems shall perform in accordance with control sequences. Refer to drawings including system diagrams, flow diagrams and related drawings showing overall system arrangement.
 - 2. System shall include of all necessary software to provide the sequences of operation. Sequence of operations describes major control functions but does not limit Contractor's responsibility to provide a fully operational automatic control system. Contractor shall provide additional control functions not specifically described including time delays, control deadbands, equipment interlocks, equipment sequencing, alarm notification, control functions recommended by equipment manufacturers, or as otherwise required.
 - 3. Provide all control devices and instrumentation required to perform the sequences whether or not specifically shown on the drawings.

1.2 DEFINITIONS

- A. The following abbreviations, acronyms, and definitions may be used herein.
 - 1. AI: Analog Input.
 - 2. AO: Analog Output.
 - 3. BAS: Building Automation System.
 - 4. DI: Digital Input.
 - 5. DO: Digital Output.
 - 6. EC: Electrical Contractor.
 - 7. NC: Normally closed position after control signal is removed.
 - 8. NO: Normally open position after control signal is removed.

1.3 SUBMITTALS

- A. Provide Action Submittals, Informational Submittals, and Close-out Submittals. Refer to 23 09 23 - Building Automation Systems for HVAC.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General.
 - 1. Control sequence of operation shall conform to ASRAE 90.1 as adopted and amended for the Oregon Energy Efficiency Specialty Code (OEESC). If conflict existing between the specified sequences and the OEESC then conform to Code.
- B. Control Programming.
 - 1. Control setpoints and parameters listed in control sequences are initial values. Adjust setpoints and control parameters as required to achieved desired environment

conditions, optimum system performance, and as recommended by the TAB contractor and/or Commissioning Agent.

2. Control parameters and setpoints listed in the sequence of operations shall be adjustable from the Operator Workstation without modification of control programming or use of proprietary software. All setpoints which are necessary for normal operation and optimization of system performance shall be adjustable, and shall include, but not be limited to: time schedules; temperature, pressure, time delay settings; safety sequence setpoints; and alarming parameters.
3. Where BAS network communications are provided to networkable control systems or equipment, Contractor shall configure accessible points for control, monitoring, and alarm as required to provide specified sequences and as directed by the Owner's Authorized Representative for trending and monitoring.

C. BAS Points List.

1. Provide all control points required to perform the automatic control sequence described herein, which as a minimum shall include all points listed in BAS Points List scheduled on mechanical drawings.
2. Point Communication: All points listed are to be hardwired to BAS controllers, except where point is identified as being communicated over a BAS network.
 - a. PTP = Hardwired point-to-point.
 - b. C = BAS network communication.
3. Point Source: All points shall be connected to field-mounted control devices, except where the point is identified as being obtained from an equipment controller identified. See Drawing Legend or equipment schedules for designation of equipment control panel abbreviations.

D. Motor Controls.

1. All safety control circuits interlocked with motor starters or VFDs shall be hardwired and shall function in all operating modes (Automatic, Hand, and Manual Bypass).
2. Hand-Off-Auto Switches.
 - a. BAS or other normal control commands shall function in the automatic position of the HOA switch.
 - b. Motors shall operate manually in the Hand position of the HOA switch.
 - c. Motors shall be off in the off position.
3. Variable Frequency Drives.
 - a. Variable speed drives shall start at minimum speed and ramp up to control speed on start-up, and ramp down from control speed to minimum speed on shutdown.
 - b. Minimum speed shall be set at 15 hz, unless otherwise indicated.
 - c. The ramp up and ramp down speed duration shall be set to 60 seconds, unless otherwise indicated.
 - d. If an electrical disconnect is installed between the VFD and the motor, then a hardwire interlock shall be provided to prevent the VFD from operating if the disconnect is open.
 - e. Where provided, changeover of VFD bypass shall be performed manually.
 - f. BAS shall be capable of control and monitoring of the following conditions:
 - 1) Motor start-stop.
 - 2) Motor speed command.
 - 3) Motor speed feedback.
 - 4) Motor amperage.
 - 5) Motor demand kW.
 - 6) VFD fault status.
 - 7) HOA status.
 - g. Motor Operating Status Detection. Motor status shall be obtained from VFD and ECM motor controller digital status output, where available; otherwise use field mounted motor amperage analog transmitters, or differential pressure switches for hydronic applications. or Motor status shall be obtained using the followings:

- 1) Motor current switch.
 - 2) Differential pressure transmitter.
 - 3) Motor amperage analog transmitter.
 - 4) VFD run status.
 - h. Safety and Emergency Interlocks.
 - 1) All critical shutdown interlocks shall be hardwired from initiating device and shall function in all operating modes including automatic, hand, and/or manual bypass positions of the HOA or VFD bypass switches.
 - 2) All critical shutdown interlocks shall also be connected to and monitored by BAS.
- E. Monitoring and Alarms.
- 1. Provide BAS alarm functions and configuration as detailed in plans and specifications, and as directed by Owner's Authorized Representative. Alarm functions may include:
 - a. Visual display on workstation graphic.
 - b. Audible alarm at workstation computer.
 - c. Listing in workstation alarm log.
 - d. "Pop-up" alarm notification at workstation computer.
 - e. Dial-out alarm to Owner's security staff or alarm monitoring service.
 - f. Email and/or cellular text message to Owner's designated contacts with custom alarm notification message containing condition description and action required.
- F. Control Network Integration.
- 1. Where BAS network communications are integrated with networkable control equipment controllers or compatible control systems, Contractor shall configure accessible points for control, monitoring, and alarm as required to provide specified sequences and as directed by the Owner's Authorized Representative for trending and monitoring.

2.2 COMMON CONTROL SEQUENCES

- A. Building Occupancy Schedules.
- 1. General: Provide time schedules for control of HVAC systems as follows:
 - a. General Building Occupancy: Time schedule for building normal occupied and unoccupied periods.
 - b. ERV-1 Occupancy: Time schedule for normal occupied and unoccupied periods .
 - c. ERV-2 & 3 Occupancy:
 - 1) Provide separate time schedules for each ventilation unit and associated water-source heat pumps. Coordinate schedules with owner.
 - 2. Optimum Start/Stop: Where indicated, provide optimum start routine to calculate system warm-up/cool down duration subject to outside air temperature and space temperatures so that all spaces are at occupied temperature at the occupied start time. Optimum start routines shall use a sophisticated algorithm that monitors historical system performance to accurately predict start-up duration and shall be capable to achieving occupied space temperature in all spaces within 2°F unless the start-up duration exceeds the maximum start-up duration setpoint. Maximum start-up duration shall be adjustable and initially set to 2 hours.
- B. Common Control Setpoints.
- 1. Zone Temperature Setpoints:
 - a. Unoccupied:
 - 1) Cooling: 82°F.
 - 2) Heating: 60°F.
 - b. Occupied:

- 1) Cooling: 75°F.
- 2) Heating: 70°F.

2.3 CONDENSER WATER SYSTEM

- A. Condenser water system serves water-source heat pumps throughout facility. System is enabled continuously, and operates with variable flow. Water temperatures range from 60°F to 95°F over course of operation. Cooling tower and boilers serve same water loop, and do not operate simultaneously. When heat pumps are primarily in heating mode, bypass cooling tower.
- B. Condenser Water Pump Operation: Pumps operate subject to individual on-off-auto switch at motor VFDs as follows.
 1. Auto Position: Operate pumps subject to BAS control sequences and hardwired safety control interlocks.
 2. On Position: Override automatic BAS control sequences and start pump. Operate pumps subject to hardwired safety control interlocks.
 3. Off Position: Pump off.
- C. Condenser Water Pump Lead/standby Control.
 1. Start lead pump whenever the water loop is enabled.
 2. Stop lag pump if lead pump status is restored.
 3. Start lag pump if lead pump status indicates that lead pump has failed:
 4. Pumps shall have a minimum 10 runtime if started.
 5. Automatically alternate lead pump weekly.
- D. Condenser Water Pump Speed Control:
 1. Modulate pump speed to maintain a water pressure difference between supply and return piping. Locate pressure transmitter where shown on Drawings.
 2. Initial pressure setpoint: 10 psig, adjustable on graphic.
- E. Condenser Water Loop Cooling Mode:
 1. On rising condenser water loop temperature, and conditions below, operate cooling tower, CT-1, in accordance with Cooling Tower Control.
 - a. Enable cooling tower to run when the following are true:
 - 1) Outside air temperature is greater than 55°F (adj).
 - 2) Condenser water loop return temperature is above 85°F (adj).
- F. Condenser Water Loop Heating Mode:
 1. On dropping condenser water loop temperature, and conditions below, operate boilers, B-1 & B-2 in sequence, in accordance with Boiler Control.
 - a. Enable boilers to run when the following are true:
 - 1) Outside air temperature is less than 55°F (adj).
 - 2) Condenser water loop return temperature below 65°F (adj).
- G. Cooling Tower Control:
 1. Monitor condenser water supply temperature and operate spray pump, cooling tower fan, and cooling tower bypass valve in sequence to maintain temperature leaving tower.
 - a. Cooling Tower Leaving Water Temperature Control.
 - 1) Tower Spray Pump.
 - a) On rising condenser water supply temperature, start the spray pump to maintain setpoint of 85°F (adj.).
 - b) Upon starting tower spray pump, minimum run time is 30 minutes (adj).
 - 2) Tower Fan:

- a) With spray pump on, and rising condenser water supply temperature start tower fan and modulate fan speed from minimum to maximum to maintain leaving water temperature between 83 and 85°F. Minimum fan speed 20%.
 - b) Upon starting tower fan, minimum run time is 30 minutes (adj).
 - b. Tower Bypass Valve:
 - 1) Tower Bypass mode:
 - a) When boilers are enabled, close condenser water flow to cooling tower.
 - 2) Tower Freeze Protection Mode:
 - a) When outside air temperature is 35°F and lower, enable mode.
 - b) Tower fan and spray pumps disabled.
 - c) Modulate bypass valve to 25% open (adj) to provide flow through tower coil.
- H. Boiler Plant Enable/Disable:
 - 1. Enable boilers to maintain minimum condenser water supply temperature. Reset boiler supply water temperature for mixing to maintain loop temperature. Each boiler is served by a dedicated circulation pump. Boiler operation is controlled by packaged boiler controls and by a boiler controller (BMP) furnished by the boiler manufacturer.
 - 2. Boiler Plant Enable/Disable:
 - a. Boiler plant BAS time schedule shall define occupied and unoccupied periods.
 - b. Enable boiler plant if any of the following conditions exist:
 - 1) Outside air temperature is 40°F or below.
 - 2) Outside air temperature is 65°F or below, and if is an occupied time.
 - c. Disable boiler plant if either of the following conditions are true:
 - 1) Outside air temperature is above 45°F and it is an unoccupied time.
 - 2) Outside air temperature is above 70°F.
- I. Boiler Control:
 - 1. BAS enables boiler controller after the Boiler Plant enabled conditions are met.
 - 2. Once enabled, the boilers shall be enabled for a minimum of 20 minutes.
 - 3. BAS to provide heating water supply temperature setpoint to boiler controller. Reset water temperature as follows:
 - a. Provide linear reset between 30°F and 55°F.
 - b. When outside air temperature is 40° and below, 80°F.
 - c. When outside air temperature is 55°, 70°F.
- J. Safety Control, Monitoring, and Alarm.
 - 1. Low Condenser Supply Water Temperature Alarm: if water temperature falls below 55°F (adj) during loop heating mode, initiate alarm on graphic.
 - 2. High Condenser Supply Water Temperature Alarm: if water temperature rises above 90°F (adj) during loop cooling mode, initiate alarm on graphic.
 - 3. Pump Status: If a motor is commanded “on” and the motor status after a 20 second delay indicates that the motor is off, activate status alarm. Maintain alarm until acknowledged by building operator.
 - 4. Fan Status: If a motor is commanded “on” and the motor status after a 20 second delay indicates that the motor is off, activate status alarm. Maintain alarm until acknowledged by building operator.
- K. Input/Output Points List: See diagram and schedule on Drawings.

2.4 WATER-SOURCE HEAT PUMPS

- A. Water source heat pumps provide heating and cooling for zones served. BAS starts and stops supply fans, controls heating and cooling modes, and cycles compressors. Upon

refrigerant detection alarm, BAS sets alarm and activates refrigerant leak detection mitigation measures. Unit packaged controller operates unit condenser water control valve.

- B. Mode of Operation: As defined by Building Occupancy Schedule.
- C. Occupied Mode.
 - 1. Fan Control: Supply fan is On.
 - 2. Zone Temperature Control:
 - a. Cooling: Stage compressor for maintaining occupied zone cooling temperature setpoint.
 - b. Deadband: Compressor off.
 - c. Heating: Reversing valve set to heat. Stage compressor for maintaining occupied zone heating temperature setpoint.
- D. Unoccupied Mode.
 - 1. Fan Control: Supply fan is Off.
 - 2. Zone Temperature Control: Compressor off.
- E. Safety Control, Monitoring, and Alarming.
 - 1. Zone Temperature Alarm: If the zone occupied mode temperature exceeds 80°F or drops below 65°, activate status alarm. Maintain alarm until acknowledged by building operator.
 - 2. Refrigerant Detection Alarm: Upon refrigeration detection alarm input, activate status alarm. Stop compressor command, enable fan and operate for a minimum period of 15 minutes. After time has elapsed, resume supply fan operation according to schedule. Maintain alarm until acknowledged by building operator.
- F. Input/Output Points List: See diagram and schedule on Drawings.

2.5 ENERGY RECOVERY VENTILATORS

- A. Energy recovery ventilators recovery are controlled by internal packaged controls. Provide output to start and stop units for occupied mode operation. Monitor unit fans with current transformer switches.
 - 1. Send enable/disable signal to units for operation with regular scheduled occupancy. Unit packaged controller operates fans, dampers, and heat recovery.
- B. Mode of Operation:
 - 1. ERV-1: Unit enabled continuously.
 - 2. ERV-2 & ERV-3: Units enabled by Building Occupancy Schedule.
- C. Safety Control, Monitoring, and Alarming.
 - 1. Fan Alarm Mode: If fan is commanded “on” and fan status after a 30 second delay indicates that the fan is off, provide a critical alarm. Set and maintain alarms until acknowledged by operator.
- D. Input/Output Points List: See diagram and schedule on Drawings.

2.6 MAKEUP AIR UNIT, CONSTANT VOLUME

- A. General: Constant volume supply fan makeup air unit with electric heating. Monitor existing range hood exhaust fan EF-2 with a CT switch, and start MAU-1 system when range hood fan is activated. Electric duct heater protected by airflow switch.

- B. Zone Time Schedule and Temperature Setpoints: Refer to Common Control Sequences, Building Occupancy Schedules and Common Control Setpoints.
- C. Mode of Operation: As defined by Building Occupancy Schedule.
- D. Occupied Mode.
 - 1. Fan Control: Supply fan is On.
 - 2. Ventilation Control: Outside air damper Open.
 - 3. Zone Temperature Control:
 - a. Cooling/Deadband: Heating output off.
 - b. Heating: Modulate duct mounted heating coil output to maintain a discharge heating temperature setpoint of 60°F.
- E. Unoccupied Mode.
 - 1. Fan Control: Supply fan is Off.
 - 2. Ventilation Control: Outside air damper Closed.
 - 3. Zone Temperature Control: Heating coil output off.
- F. High Low Limit Mode: Same as Unoccupied Mode.
- G. Cold Starting Mode:
 - 1. Implement mode when Outside air is below 50°F (adj.).
 - 2. Prior to starting supply fan, close automatic bypass damper for outside air (open to ceiling plenum return air) to supply fan.
 - 3. Start supply fan. Modulate supply air temperature in accordance with Occupied Mode.
 - 4. After five minutes (adj.) has elapsed, modulate outside air damper open, closing bypass damper. Tune damper operation for stable duct heater temperature control.
- H. Safety Control, Monitoring, and Alarming.
 - 1. Zone Heater Alarms, maintain alarm until acknowledged by building operator.:
 - a. If the duct heater controller indicates fault status alarm.
 - b. Low-airflow alarm.
 - c. High-temperature alarm.
 - 2. Freeze Protection: Activate freeze protection alarm when supply temperature is less than 40°F. Stop fan. Automatically attempt re-start three (adjustable) times. If unit stops following third attempt, set and maintain alarms until acknowledged by operator.
 - 3. Fan Status Alarm: If a motor is commanded "on," and the motor status after a two minute delay indicates that the motor is off, activate status alarm. Maintain alarm until acknowledged by building operator.
- I. Input/Output Points List: See diagram and schedule on Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install complete control system including all components, devices, and accessories required to perform specification sequence of operation and provide intended system performance.

END OF SECTION

SECTION 231123

FACILITY NATURAL-GAS PIPING AND SPECIALITES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes pipe, fittings, and specialty equipment related to natural gas service.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig, but not more than 2 psig and is reduced to secondary pressure of 0.5 psig or less.

1.4 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
 - 1. Materials List.
 - 2. Catalog Data.
 - 3. Product Data.
 - 4. Performance Data.
 - 5. Wiring Diagrams.
 - 6. Shop Drawings.
 - 7. Installation Instructions.
 - 8. Special Requirement listed herein

PRODUCT TABLE	1	2	3	4				
Pipes, Tubes, and Fittings	x							
Piping Specialties		X						
Manual Gas Shutoff Valves		X						
Pressure Regulators		X						

- B. Special Requirements.
 - 1. Manual Gas Shutoff Valves and Motorized Gas Valves: Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 2. Pressure Regulators: Include pressure ratings and capacities.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 PROJECT CONDITIONS

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

PART 2 PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections,

and facings:

- a. Material Group: 1.1.
- b. End Connections: Threaded or butt welding to match pipe.
- c. Lapped Face: Not permitted underground.
- d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
- e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless-steel underground.

2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 3. Corrugated stainless-steel tubing with polymer coating.
 4. Operating-Pressure Rating: 0.5 psig.
 5. End Fittings: Zinc-coated steel.
 6. Threaded Ends: Comply with ASME B1.20.1.
 7. Maximum Length: 72 inches.
- B. Y-Pattern Strainers:
 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for NPS 2 smaller; flanged ends for NPS 2-1/2.
 3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
 4. CWP Rating: 125 psig.

2.3 JOINING MATERIALS

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

2.4 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 1. CWP Rating: 125 psig.
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Listing: Listed and labeled by a Nationally Recognized Testing Laboratory acceptable to authorities having jurisdiction for valves 1-inch and smaller.
 5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- B. General Requirements for Metallic Valves, NPS 2-1/2 Larger: Comply with ASME B16.38.
 1. CWP Rating: 125 psig.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of

the following:

- a. A.Y. McDonald Mfg. Co.
 - b. BrassCraft Manufacturing Co., a Masco company.
 - c. Conbraco Industries, Inc.
2. Body: Bronze, complying with ASTM B 584.
 3. Ball: Chrome-plated bronze.
 4. Stem: Bronze; blowout proof.
 5. Seats: Reinforced TFE; blowout proof.
 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 7. Ends: Threaded or flanged to match piping.
 8. CWP Rating: 600 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

- A. General Requirements:
 1. Single stage and suitable for natural gas.
 2. Steel jacket and corrosion-resistant components.
 3. Elevation compensator.
 4. End Connections: Threaded for regulators NPS 2 smaller; flanged for regulators NPS 2-1/2.

- B. Line Pressure Regulators: Comply with ANSI Z21.80.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Meter Company.
 - b. Fisher Control Valves & Instruments, a brand of Emerson Process Management.
 - c. Maxitrol Company.
 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 11. Maximum Inlet Pressure: 2 psig.

- C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. Maxitrol Company.
 2. Body and Diaphragm Case: Die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber.
 6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.

8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless approved by Engineer.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.

- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- S. Do not use natural-gas piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and electrically operated valve.
- U. Install pressure gage downstream from each line regulator.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs.
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of connector.
- B. Install regulators with maintenance access space adequate for servicing and testing.

3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads.

5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 2. Bevel plain ends of steel pipe.
 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

3.7 CONNECTIONS

- A. Install piping adjacent to appliances to allow service and maintenance of appliances.
- B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 FIELD QUALITY CONTROL

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

3.9 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 2 PSIG

- A. Aboveground piping 2-inch and smaller shall be:
1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground piping 2-1/2 inch and larger shall be:
1. Steel pipe with wrought-steel fittings and welded joints.

END OF SECTION

SECTION 232113

ABOVE GROUND HYDRONIC PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes pipe, fittings, and joining methods for HVAC systems.

1.2 PERFORMANCE REQUIREMENTS

- A. All hydronic piping, equipment, fittings, and accessories shall be capable of withstanding the following maximum pressure and temperature. Exceptions would include specific items of equipment where a lower operating pressure is specified.
 - 1. Hot-Water Heating Piping:
 - a. Maximum operating pressure: 125 psig.
 - b. Maximum operating temperature: 200°F.
 - 2. Condenser-Water Piping:
 - a. Maximum operating pressure: 125 psig.
 - b. Maximum operating temperature: 150°F.
 - 3. Makeup-Water Piping:
 - a. Maximum operating pressure: 125 psig.
 - b. Maximum operating temperature: 100°F.
 - 4. Condensate-Drain Piping:
 - a. Maximum operating pressure: 50 psig.
 - b. Maximum operating temperature: 70°F.
 - 5. Air-Vent Piping:
 - a. Same as connected service pressure.
 - b. Same as connected service temperature.
 - 6. Safety-Valve-Inlet and -Outlet Piping:
 - a. Same as connected service pressure.
 - b. Same as connected service temperature.

1.3 ACTION SUBMITTALS

- A. Provide materials list for pipe and fittings.
- B. Provide catalog data for dielectric fittings.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate

ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design:
 - 1. Piping layout including plans, sections, and details for piping and accessories.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Drawn-Temper Copper Tubing: ASTM B 88, Type M.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.

2.3 STAINLESS STEEL TUBING

- A. Tubing: 316L stainless steel tubing.
- B. Fittings: 316 stainless steel Swagelok compression fittings.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

- A. Above ground hot-water heating piping, NPS 2 and smaller, shall be the following:
 - 1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

- B. Above ground hot-water heating piping, NPS 2-1/2 and larger, shall be the following:
 1. Type L drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
- C. Condenser-water piping, NPS 2 and smaller, shall be the following:
 1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- D. Condenser-water piping, NPS 2-1/2 and larger, shall be either of the following:
 1. Type L drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
- E. Makeup-water piping shall be the following:
 1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- F. Condensate-Drain Piping:
 1. 1-1/4 and larger: Type DWV drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. 1" and smaller: Type M drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- G. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- H. Air-Vent Piping:
 1. Inlet: Same as service where installed.
 2. Outlet: Type Annealed-temper copper tubing with soldered or flared joints.
- I. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
- J. Connectors, Flexible Mechanical Couplings as specified in 23 21 16 - Hydronic Piping Specialties: Flexible grooved, mechanical joint coupling and fittings.
- K. Control and Instrumentation Piping:
 1. 3/8-inch stainless steel tubing, unless otherwise indicated on drawings.

3.2 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains at supply connection to each piece of equipment, and where shown on drawings.
- B. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
- D. Install control valves according with manufacturer's instructions. Verify control valve port arrangement provides the intended function. Notify Engineer of any potential conflict between valve arrangement shown on plans and control valve installation requirements prior installing valves. Any control valves installed with incorrect connections will be re-piped to provide correct function at no expense to the Owner.
 1. Three-way control valve arrangement shown on plans is based on typically valve configuration. Verify three-way control valve connections prior to installing valves.

3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved by Engineer.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for complete system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

- S. Flexible Mechanical Coupling Connectors: Refer to 23 21 16 - Hydronic Piping Specialties for installation requirements.
- T. Flush and fill systems with fluid. Coordinate and assist with installation of chemical treatment equipment and testing. Refer to 23 25 13 - Water Treatment for Hydronic Systems.
- U. Provide temporary facilities required for cleaning and treatment of piping connected to existing hydronic systems:
 - 1. Provide temporary recirculation bypass assembly including:
 - a. Shutoff valves to isolate new work from existing system.
 - b. Temporary recirculation pipe connections with shutoff valves and caps.
 - c. Bypass piping with isolation valve to enable circulation in new section of piping.
 - d. Drain valves as required.
 - e. Coordinate with treatment specialist. Refer to 23 25 13 - Water Treatment for Hydronic Systems.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 - Hangers and Supports for HVAC Piping and Equipment for hanger, support, and anchor devices.
- B. Support vertical runs at roof and at each floor.

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance."
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.

3.7 CHEMICAL TREATMENT

- A. Install piping connections for chemical treatment equipment. Conform to 23 25 13 - Water Treatment for Closed-Loop Hydronic Systems.

3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens. Repeat process until systems are clean and no debris is found in fluid or strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 - 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 - 6. Prepare written report of testing.

END OF SECTION

SECTION 232116

HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes special-duty valves and specialties for hydronic piping applications.

1.2 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
 1. Materials List.
 2. Catalog Data.
 3. Product Data.
 4. Performance Data.
 5. Wiring Diagrams.
 6. Shop Drawings.
 7. Installation Instructions.
 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Flow Measurement Devices	X		X	X			X	X
Air Control Devices		X						
Expansion Tanks		X		X				
Strainers		X						
Connectors			X					X

- B. Special Requirements.
 1. Hydronic Specialty Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 2. Balancing Devices: Provide instrument schedule listing each balancing device furnished along with model number, line size, design flow, permanent pressure drop, and measurement differential pressure at design flow.
 3. Flexible Spherical Expansion Joints: Provide written verification from supplier that control rods have been provided where the manufacturer determines the installation exceeds the pressure requirement without control rods.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 PRODUCTS

2.1 FLOW MEASUREMENT DEVICES

- A. Venturi Flow Measurement:
 - 1. Acceptable Manufacturer: Armstrong, Tour Anderson, or approved.
 - 2. Venturi flow measuring device with built-in sensing taps, nipples, shut-off valves, quick connect couplings, and identification tag showing size, design, flow rate, and pressure difference. One-piece cadmium plated, cast-iron steel, flanged ends.
 - 3. Size In accordance with manufacturers' recommendations. Permanent pressure drop shall not exceed 3 feet water column.

2.2 AIR-CONTROL DEVICES

- A. Manual Air Vents:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. Nexus Valve, Inc.
 - 2. Body: Bronze.
 - 3. Internal Parts: Nonferrous.
 - 4. Operator: Screwdriver or thumbscrew.
 - 5. Inlet Connection: NPS 1/2.
 - 6. Discharge Connection: NPS 1/8.
 - 7. CWP Rating: 150 psig.
 - 8. Maximum Operating Temperature: 225°F.
- B. Automatic Air Vents:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Spirotherm, Inc.
 - d. Taco.
 - 2. Body: Bronze or cast iron.
 - 3. Internal Parts: Nonferrous.
 - 4. Operator: Noncorrosive metal float.
 - 5. Inlet Connection: NPS 1/2.
 - 6. Discharge Connection: NPS 1/4.
 - 7. CWP Rating: 150 psig.
 - 8. Maximum Operating Temperature: 240°F.
- C. Coalescing Air Separators, AS-1.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the

following:

- a. Spirotherm.
- b. Taco.
- c. Wessels.
2. Basis of Design: Spirotherm, Spirovent Series VSR or VHR.
3. Tank: Fabricated steel tank; ASME constructed and stamped for 150-psig working pressure and 270°F maximum operating temperature.
4. Coalescing Medium: Copper or stainless steel.
5. Air Removal: Venting chamber to prevent system contaminants from harming float and venting valve operation. Integral full port float actuated brass venting mechanism at the top of the venting chamber. Valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
6. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
7. Blowdown Connection: Threaded to the bottom of the separator.
8. Size: As scheduled on Drawings.

2.3 EXPANSION TANKS

A. Diaphragm-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Taco.
 - d. Wessels.
2. Tank: Vertical welded steel, rated for 125-psig working pressure and 375°F maximum operating temperature. Factory test after taps are fabricated and supports installed. Labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Galvanized or epoxy coated.
3. Diaphragm: Butyl rubber. Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Capacity: As scheduled on drawings.

2.4 STRAINERS

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong.
 - b. Mueller Steam Specialty.
 - c. Spirax Sarco,
 - d. Watts.
2. Body: Bolted cover and threaded bottom blowoff outlet connection.
 - a. Steel Piping System: ASTM A 126, Class B, cast iron.
 - b. Copper Piping Systems: Bronze.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Screen:
 - a. Free area of strainer element no less than four times the pipe cross sectional area.
 - b. Material.
 - 1) Closed, chemically treated hydronic systems: Stainless-steel.
 - 2) Open or non-chemically treated hydronic systems: Brass.
 - c. Size.

- 1) 2-inch and Smaller: 20 mesh.
 - 2) 2-1/2 inch to 4-inch: 1/16-inch perforations.
5. CWP Rating: 125 psig.

2.5 CONNECTORS

- A. Flexible Copper/Bronze Hose Connectors.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 2. Basis of Design:
 - a. 2-inch and Smaller: Mason Industries MN or CPS Series.
 - b. 2-1/2 inch and Larger: Mason Industries FFL or CPS Series.
 3. Construction:
 - a. Steel Piping Systems: Stainless steel braid and carbon steel fittings.
 - b. Copper Piping Systems: Braided bronze hose with copper ends.
 4. Minimum Face to Face Length:
 - a. 2-inch and smaller, 12 inches.
 - b. 2-1/2 inch and larger, 18 inches.
 5. Connection.
 - a. Steel.
 - 1) 2-inch and Smaller: Male nipple.
 - 2) 2-1/2 inch and Larger: Flanged hoses with one fixed and one floating raised face carbon steel plate flange.
 - b. Copper: Sweat connection.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install equipment in accordance with manufacturer's recommendations.
- B. Safety Relief Valve: Install where shown on drawings. Pipe to nearest drain. Provide pressure relief setting shown on Drawings.
- C. Flow Meters:
1. Install in piping where shown on Drawings. Install with minimum lengths of straight upstream and downstream pipe without valves or fittings in accordance with manufacturer's recommendations. Piping in straight upstream and downstream sections to be same size as balancing device connection.
 2. Install so temperature and pressure probes can easily be inserted and removed.
- D. Air Vents.
1. Install automatic air vents and associated drain piping to floor drain or floor sink at the following locations.
 - a. Air separator vent connection.
 - b. High points in mechanical rooms.
 2. Install manual air vents at all other high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
 3. Provide isolation valve at each air vent.
- E. Air Separator.
1. Provide suitable support for separator. Do not support from adjacent piping.

2. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
 3. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
 4. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- F. Expansion Tanks.
1. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 2. Install tank fittings that are shipped loose.
 3. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
 4. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.
- G. Y-Pattern Strainers.
1. Locate where shown on drawings and ahead of reducing valves, automatic control valves, and pumps.
 2. Arrange for easy access.
 3. Provide ball valve with hose end connection on blowoff outlet of hydronic system strainers two inches and larger.
 4. Provide pressure gauges on strainers 4-inch and larger. Pipe to strainer inlet and outlet. Provide ball valve at each connection.
- H. Connectors:
1. Install with no misalignment of piping and equipment connections.

3.2 APPLICATION

- A. Connectors: Provide where flexible pipe connections are shown on drawings or as otherwise specified to accommodate piping expansion, vibration control, or seismic movement.
1. Piping 2-inch and below: Copper/Bronze Hose Connectors.
 2. Piping 2-1/2 and larger: Flexible mechanical couplings.
 3. Provide connectors for all piping to accommodate seismic differential motion. See 23 05 48 - Vibration and Seismic Controls for HVAC, "Accommodation of Differential Seismic Motion".
 4. Provide connectors at equipment connections for all equipment that has vibration isolation supports.

3.3 ADJUSTMENT

- A. Diaphragm Expansion Tank: Adjust tank charge pressure to the system make-up pressure setpoint plus 2 psig. Adjust for elevation differences between the expansion tank and make-up pressure regulator.

END OF SECTION

SECTION 232123

HYDRONIC PUMPS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. In-line centrifugal pumps.
 - 2. Pump Specialty Fittings.

1.2 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.3 QUALITY ASSURANCE

- A. Pump and motor combination shall operate at specified system fluid temperatures without vapor binding or cavitation and are non-overloading in parallel or individual operation.
- B. Pumps shall conform to ANSI/HI 9.6.1-1997 standards for Centrifugal and Vertical Pumps for NPSH Margin.
- C. Pump impeller diameter shall not exceed 90% of maximum impeller diameter.
- D. If equipment is approved which has different flow or pressure drop requirements than scheduled, contractor shall select new pumps with capacity and pressure capabilities adjusted to maintain scheduled pump efficiency and requirements. Select pumps so that the head-capacity curve slopes up to maximum pressure at shut-off. Contractor will provide all additional or larger electrical components required by an approved pump having greater horsepower than scheduled.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: For each pump.
 - 1. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 PRODUCTS

2.1 IN-LINE CENTRIFUGAL PUMPS

- A. Close-coupled, In-line Booster Pumps (Small In-line).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Xylem, Bell and Gossett.
 - b. PACO Pumps; Grundfos Pumps Corporation, USA.
 - c. TACO Comfort Solutions, Inc.
 - d. Patterson Pump Company.
 - 2. Description: Factory-assembled and tested, centrifugal, close-coupled, in-line pump; designed for installation with pump and motor shafts mounted horizontally.
 - 3. Pump Construction.
 - a. Casing: Cast iron, rated for 125 psig working pressure.
 - b. Trim: Bronze fitted.
 - c. Impeller: Stainless steel, enclosed type.
 - d. Shaft: Stainless steel or carbon steel with bronze or stainless-steel sleeves through seal chamber.
 - e. Seals: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring with Buna-N bellows and gasket. Include water slinger.
 - f. Bearings: Permanently lubricated ball bearings or oil lubricated bronze sleeve.
 - g. Piping Connections: Flanged.
 - h. Motors: Provided hereunder, see Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
 - i. Capacity: As scheduled on Drawings.

2.2 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser:
 - 1. Angle pattern.
 - 2. 175-psig (1204-kPa) pressure rating, iron body and end cap, pump-inlet fitting.
 - 3. Bronze startup and bronze or stainless-steel permanent strainers.
 - 4. Bronze or stainless-steel straightening vanes.
 - 5. Drain plug.
 - 6. Factory-fabricated support.
 - 7. Maximum Pressure Drop: 2.0 psi at design flow rate.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps to allow access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- C. In-line Pump:
 - 1. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC.
 - 2. Comply with requirements for hangers and supports specified in Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

3.3 ALIGNMENT

- A. Record field adjustments and include in the O & M manual.

3.4 CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping. Install reducers or increasers as required at pump connections.
- C. Provide pump trim as detailed on drawings.
- D. Provide pressure gauge. Connect gauge to pump suction and discharge casing gauge taps. Provide ball valve at each connection.
- E. Install check valve and gate or ball valve on each condensate pump unit discharge.

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains and prepare pump for operation.

6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

SECTION 232513

WATER TREATMENT FOR HYDRONIC SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes the water treatment for the following systems:
 - 1. Closed-loop hydronic systems.
 - 2. Open-loop hydronic condenser water systems.

1.2 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- B. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
 - 1. Bypass feeders.
 - 2. Water meters.
 - 3. Inhibitor injection timers.
 - 4. pH controllers.
 - 5. TSS controllers.
 - 6. Chemical solution tanks.
 - 7. Injection pumps.
 - 8. Chemical test equipment.
 - 9. Chemical material safety data sheets.
- B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- B. Field quality-control reports.
 - 1. Utility supply water analysis.
 - 2. Pre-construction water analysis.
 - 3. Construction test and inspection.
 - 4. Post construction test water testing.
- C. Other Informational Submittals:
 - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance

Requirements" Article.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- B. Existing Closed Loop Hydronic Systems: The Contractor is responsible for cleaning and treating the entire condenser water system including new boilers, closed circuit cooling tower, and water source heat pumps.

1.7 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
 - 1. HVAC water-treatment recommendations.
 - 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
 - 3. Periodic field service and consultation.
 - 4. Customer report charts and log sheets.
 - 5. Laboratory technical analysis.
 - 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
 - 1. Garrett Callahan.
 - 2. ChemAcqua.
 - 3. Nalco; an Ecolab company.
 - 4. US Water Service.

2.2 CLOSED-LOOP HYDRONIC SYSTEMS

- A. Performance Requirements:
 - 1. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
 - 2. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

3. Closed hydronic systems, including condenser water shall have water characteristic as recommended by the chemical treatment manufacturer for the treatment chemicals provided and as follows:
 - a. pH: Maintain a value within 7.5 to 10.5 and as recommended for treatment chemicals used.
 - b. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - c. Soluble Copper:
 - 1) New hydronic pipe system: Maintain a maximum value of 0.20 ppm; or make-up water copper concentration, whichever is greater.
 - 2) Expansion of existing hydronic pipe system: Maintain a maximum value of 1.0 ppm. If make-up water copper concentration is greater than 1.0, maintain a maximum value of the make-up water concentration plus 1 ppm.
 - d. Turbidity: 0-50 NTU.
 - e. Microbiological Limits: Maintain the following for expansion of existing hydronic piping system.
 - 1) Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
 - 2) Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.

B. Chemicals.

1. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

2.3 COOLING TOWER OPEN-LOOP SPRAY WATER SYSTEMS

A. Performance Requirements:

1. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of equipment without creating a hazard to operating personnel or the environment.
2. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
3. Open HVAC systems, including fluid-cooler spray water shall have the following water qualities:
 - a. pH: Maintain a value within 8.0 to 9.1.
 - b. "P" Alkalinity: Maintain a maximum value of 100 ppm.
 - c. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
 - d. Soluble Copper: Maintain a maximum value of 0.20 ppm.
 - e. TSS: Maintain a maximum value of 10 ppm.
 - f. Ammonia: Maintain a maximum value of 20 ppm.
 - g. Free "OH" Alkalinity: Maintain a maximum value of zero ppm.
 - h. Microbiological Limits: Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/mL.

B. Passivation for Galvanized Steel: For the first 60 days of operation.

1. Maximum temperature: 80°F.
2. pH: Maintain a value within 7 to 8.
3. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
4. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.

C. Automatic Chemical-Feed Control Panel.

1. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
 - a. ChemAqua.

- b. Nalco; an Ecolab company.
 - c. US Water Service.
2. General: Water treatment control system, factory assembled, pre-piped, pre-wired consisting of water treatment controller, sample piping, sensors, flow meters, and output relays for controlling treatment pumps and blowdown valves. Water quality monitoring functions shall include:
- a. Make-up water flow.
 - b. Conductivity.
 - c. pH.
 - d. Fluorescence.
 - e. Oxygen reduction potential (ORP).
3. Control Panel: Corrosion resistant, NEMA 250, Type 12 with gasketed and lockable door.
4. Treatment Controller.
- a. Microprocessor-based controller with digital display and touch pad user interface.
 - b. Display current measured values.
 - c. Functions.
 - d. High, low, and normal pH indication.
 - e. High- or low-pH-alarm-light trip points, field adjustable; with silence switch.
 - f. High, low, and normal conductance indication.
 - g. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
 - h. Bleed-off valve activated indication.
 - i. Digital display of makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.
 - j. Biocide Feeder Timer:
 - 1) 24-hour timer with 14-day skip feature to permit activation any hour of day.
 - 2) Solid-state alternator to enable use of two different formulations.
 - 3) 24-hour display of time of day.
 - 4) 14-day display of day of week.
 - 5) Hand-off-auto switches for biocide pumps.
 - 6) Biocide A and Biocide B pump running indication.
 - k. Programmable relay timers with infinite adjustment over full range.
 - l. Hand-off-auto for chemical pump and blowdown valve relays.
 - m. Indicator lights to indicate when relays are activated.
 - n. Battery backup so clock is not disturbed by power outages.
 - o. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - p. BAS Interface: Factory install hardware and software to enable BAS system to monitor, control, and display status and alarms.
 - 1) Communication Interface: Modbus RS-485 or BACnet IP communication interface compatible with BAS system shall enable control system operator to remotely monitor the system from an operator workstation. Control features and monitoring points displayed locally monitoring panel shall be available through the control system, including, as a minimum, the following:
 - a) Current value of all measured conditions.
 - b) Input sensor alarm.
 - c) Output relay status.
 - d) Timer status.
 - e) Totalized water meter consumption.
 - f) Alarm status for all alarm conditions.
 - q. Web Interface: Factory install hardware and software to enable remote access from internet browser. Program and configure manufacturers standard graphic display screens to conform with project conditions. Provide graphic displays will include:

- 1) Process diagram with current input and output values and timer status.
 - 2) Table diagram of sensors with current values and setpoints, digital inputs, timer description and status, and water meter totalized consumption.
 - 3) Table diagram of alarm conditions with current status and setpoint values.
 - r. Similar to Chemaqua, AquaDART Advanced.
 5. Piping:
 - a. PVC piping with isolation valves for sample water supply and return.
 - b. Sample water flow sensor and visual flow indicator.
- D. Automatic Chemical-Feed Equipment.
1. Bleed Valves: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
 2. Water Meter:
 - a. WWA C701, turbine-type, totalization meter.
 - b. Body: Bronze or Epoxy-coated cast iron.
 - c. Minimum Working-Pressure Rating: 150 psig.
 - d. Maximum Pressure Loss at Design Flow: 3 psig.
 - e. Registration: Gallons or cubic feet.
 - f. End Connections: Flanged.
 - g. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac, and that will close at adjustable increments of total flow.
 - h. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. Chemical Solution Tanks:
 - a. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
 - b. Molded cover with recess for mounting pump.
 - c. Capacity: 20 gallons.
 - d. Integral double-wall spill containment or provide pallet type spill containment base with minimum 110 percent capacity of supported tank volume.
 4. Chemical Solution Injection Pumps:
 - a. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
 - b. Adjustable flow rate.
 - c. Metal and thermoplastic construction.
 - d. Built-in relief valve.
 - e. Fully enclosed, continuous-duty, single-phase motor.
 - f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 5. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless-steel for steam boiler injection assemblies.
 6. Injection Assembly:
 - a. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
 - b. Ball Valve: Three-piece stainless steel as described in "Stainless-Steel Pipes and Fittings" Article; selected to fit quill.
 - c. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
 - d. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200°F.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Comply with requirements in Section 230548 - Vibration and Seismic Controls for HVAC for seismic restraints.
- C. Install water testing equipment on wall near water chemical application equipment.
- D. Install interconnecting control wiring for chemical treatment controls and sensors.
- E. Mount sensors and injectors in piping circuits.
- F. Provide temporary facilities for cleaning and treatment of existing hydronic systems:
 - 1. Coordinate installation of temporary recirculation bypass assembly including:
 - a. Shutoff valves to isolate new work from existing system.
 - b. Temporary recirculation pipe connections with shutoff valves and caps.
 - c. Bypass piping with isolation valve to enable circulation in new section of piping.
 - d. Drain valves as required.
 - e. Refer to 23 21 13 - Above Ground Hydronic Piping.
 - 2. Provide tanks, pumps, piping, and related facilities as required to perform work.

3.2 CLOSED LOOP SYSTEMS

- A. Cleaning and Treatment of Closed-Loop Hydronic Systems:
 - 1. Clean and flush existing condenser water system thoroughly prior to equipment replacement.
 - a. Open all valves and make adjustment as necessary to ensure water flow through all piping sections.
 - b. Add cleaning compound to system and circulate for duration recommended by manufacturer.
 - c. Clean strainers at ends of system branches.
 - d. Verify water flow through hydraulically most remote circuits on each system branch.
 - 2. After system equipment installation, clean and flush water system thoroughly prior to adding chemical treatment.
 - a. Open all valves and make adjustment as necessary to ensure water flow through all piping sections.
 - b. Clean all strainers.
 - c. Add cleaning compound to system and circulate for duration recommended by manufacturer.
 - d. Flush system to force material to strainers.
 - e. Clean strainers and repeat process until no more material is collected in strainers; and water quality is equivalent to make-up and fluid drawn from any branch line is clear when observed in a white cup.
 - f. Add corrosion inhibitor and recirculate system for a minimum of 8 hours. If inhibitor concentration is below manufacturer's recommendations, add more inhibitor and repeat process until the required conditions are obtained.

3.3 START-UP

- A. Engage a factory-authorized service representative to perform startup service for automatic feed controls.
- B. Complete installation and startup checks according to manufacturer's written instructions.
- C. Inspect field-assembled components, equipment installation, piping, controls and electrical connections for proper assembly, installation, and connection.
- D. Verify that treatment sensors are calibrated.
- E. Operate each relay. Verify output function.
- F. Test and adjust control setpoints, alarms, and safeties. Replace damaged or malfunctioning controls and equipment.
- G. Prepare test and inspection startup reports.

3.4 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. **Utility Water Analysis:** Perform an analysis of utility supply water to determine quality of water available at Project site.
- C. **Pre-construction Cleaning Summary:** Provide summary of steps completed during system cleaning, and confirmation of system flow at most remote system circuits.
- D. **Construction Tests and Inspections:** Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Perform water analysis prior to adding water treatment chemicals. Flushing is not acceptable if soluble copper concentration exceeds 1.0 ppm greater than make-up water copper concentration. Reflush and fill system as required.
 - 4. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
 - 5. Do not enclose, cover, or put piping into operation until it is tested, and satisfactory test results are achieved.
 - 6. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 7. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 8. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 - 9. Repair leaks and defects with new materials and retest piping until no leaks exist.

- E. Post Construction Tests: At six-week intervals following Substantial Completion for a duration of six months, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- F. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
- B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION

SECTION 233300

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Accessories for duct systems.

1.2 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 230500 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:

1. Materials List.
2. Catalog Data.
3. Product Data.
4. Performance Data.
5. Wiring Diagrams.
6. Shop Drawings.
7. Installation Instructions.
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Manual Volume Dampers		X						
Control Dampers			X	X				
Duct Silencers			X	X		X		X
Turning Vanes		X						
Plenum and Duct Mounted Access Doors			X					
Flexible Connectors		X						
Flexible Ducts		X						
Automatic Balance Dampers			X					

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless

otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cesco Products; a division of MESTEK, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.
 - 4. Pottorff.
 - 5. Ruskin Company.
- B. Basis of Design: Greenheck WDR-53.
- C. Description: Gravity balanced.
- D. Maximum Air Velocity: 2000 fpm.
- E. Maximum System Pressure: 3-inch wg.
- F. Frame: Hat-shaped, 0.035-inch-thick galvanized steel, with welded corners or mechanically attached and mounting flange.
- G. Blades: Multiple single-piece blades, end pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.
- H. Blade Action: Flap type.
- I. Blade Seals: Neoprene/EPDM blend, mechanically locked.
- J. Blade Axles:
 - 1. Material: Plated-steel.
 - 2. Diameter: 0.50 inch.
- K. Tie Bars and Brackets: Galvanized-steel.
- L. Return Spring: Adjustable tension.
- M. Bearings: synthetic pivot bushings.

- N. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gauge minimum.
 - b. Sleeve Length: 6 inches minimum.
 - 3. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS

- A. Acceptable Manufacturers.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Greenheck.
 - b. Nailor Industries Inc.
 - c. Pottorff.
 - d. Ruskin Company.
 - e. Trox USA Inc.
 - f. Young Regulator Company.
- B. Round/Oval Single Blade Manual Volume Dampers:
 - 1. Operating Conditions:
 - a. Maximum temperature: 180°F.
 - b. Maximum differential pressure: 1-inch water column.
 - c. Maximum air velocity: 2,000 fpm.
 - d. Standard leakage rating.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames:
 - a. One piece 20-gauge construction. Material to match connected ductwork.
 - 4. Blades:
 - a. Single blade.
 - b. 20-gauge construction. Material to match connected ductwork.
 - c. Stiffen damper blades for stability.
 - 5. Blade Axles: Minimum 3/8-inch diameter plated steel or stainless steel, except stainless steel where adjacent ductwork is aluminum or stainless steel.
 - 6. Bearings:
 - a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.
 - b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 7. Actuator:
 - a. Manual locking quadrant, except where remote damper operator is required.
 - b. Elevated platform for insulated duct mounting.
- C. Round Multiple Blade Manual Volume Dampers:
 - 1. Operating Conditions:
 - a. Maximum temperature: 180°F.
 - b. Maximum differential pressure: 4-inch water column.
 - c. Maximum air velocity: 2,500 fpm.
 - d. Standard leakage rating.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames:
 - a. One piece 10-gauge construction. Material to match connected ductwork.
 - 4. Blades:
 - a. Multiple blade.
 - b. 16-gauge construction. Material to match connected ductwork.

- c. Stiffen damper blades for stability.
 - 5. Blade Axles: Minimum 1/2-inch diameter plated steel or stainless steel, except stainless steel where adjacent ductwork is aluminum or stainless steel.
 - 6. Bearings:
 - a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.
 - b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 7. Actuator:
 - a. Manual locking quadrant, except where remote damper operator is required.
 - b. Elevated platform for insulated duct mounting.
- D. Single Blade Rectangular Manual Volume Dampers:
 - 1. Operating Conditions:
 - a. Maximum temperature: 180°F.
 - b. Maximum differential pressure: 1-inch water column.
 - c. Maximum air velocity: 2,000 fpm.
 - d. Standard leakage rating.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames: Hat-shaped, welded or gusset reinforced corners. 18-gauge construction. Material to match connected ductwork.
 - 4. Blades:
 - a. Single blade.
 - b. 20-gauge construction. Material to match connected ductwork.
 - c. Stiffen damper blades for stability.
 - 5. Blade Axles: Minimum 1/2 inch dia. plated steel or stainless steel, except stainless steel where adjacent ductwork is aluminum or stainless steel.
 - 6. Linkages: Concealed in jamb outside or air stream.
 - 7. Bearings:
 - a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.
 - b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Actuator:
 - a. Manual locking quadrant, except where remote damper operator is required.
 - b. Elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

- A. High Performance Control Dampers, Standard and Insulated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Tamco.
 - 2. Basis of Design:
 - a. Standard: Tamco Series 1000.
 - b. Insulated: Tamco Series 9000.
 - 3. Operating Conditions: -40°F to 210°F.
 - 4. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - a. Leakage Class: 1A at 1-inch w.g. static pressure differential.
 - 5. Frames:
 - a. U shaped 6063-T5 extruded channel, 12-gauge thickness.
 - b. Blade Width: 4-inch or 6-inch as required.
 - c. Flanged connections on both sides.
 - d. Frame Seal: Extruded silicone mechanically fastened in integral slot within frame extrusion.

6. Blades:
 - a. Multiple opposed blade design, except parallel blade where otherwise indicated.
 - b. 6063-T5 extruded aluminum, 16-gaugethick dual skin air-foil with overlapping seal surface.
 - c. Blade Seal: extruded EPDM mechanically fastened in slot of overlapping blade extension.
 - d. Uninsulated, except where otherwise indicated. Insulated blades filled with expandable polyurethane foam.
7. Blade Axles: 7/16-inch hexagonal control shaft; galvanized steel; blade-linkage hardware of aluminum or zinc-plated steel.
8. Bearings:
 - a. Dual bearing system composed of a Celcon inner bearing, fixed around aluminum blade pivot pin, rotating within a polycarbonate outer bearing inserted in the frame.
9. Actuators: Comply with 23 09 25 - BAS Field Mounted Devices for HVAC.

2.6 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Elgen Manufacturing.
 4. SEMCO LLC.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- C. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- D. Vane Construction: Single wall for ducts up to 18 inches wide and double wall for larger dimensions.

2.7 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Elgen Manufacturing.
 4. Hardcast, Inc.
 5. JP Lamborn Co.
 6. Ventfabrics, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.

- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200°F.

2.8 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

2.9 AUTOMATIC BALANCE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, but are not limited to the following:
 - 1. Greenheck.
 - 2. Aldes.
 - 3. Ruskin.
- B. Automatic balance dampers:
 - 1. Pressure independent automatic adjusting airflow damper.
 - 2. Frame and Blades: Reinforced UL 94 thermoplastic resins.
 - 3. Manually adjustable airflow setpoint with adjustment arm.
 - 4. Airflow Range: 25 to 425 cfm, depending on damper size.
 - 5. Pressure range: 0.20 to 2" w.c.
 - 6. Duct connection: size to match branch duct, range from 4" to 8" diameter.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts.
- C. Install products in locations that are accessible and that will permit adjustment and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- D. Manual Volume Dampers:
 - 1. Install in ductwork where shown on drawings and as required to properly balance airflow rates to values shown on Drawings. Provide damper for each air inlet and outlet.
 - 2. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 3. Dampers must be accessible to allow inspection, adjustment, and replacement of components.

- a. Where manual actuators are not accessible for adjustment provide remote manual cable actuator. An actuator is not accessible if it is located more than 24 inches horizontally from an access point or more than 48 inches above an access point. Coordinate location of actuator drive assembly with Architect.
 - 4. Do not compress or stretch the damper frame into the duct or opening. Damper shall move freely throughout full range of travel.
 - 5. Dampers shall be rigid and secure not producing any audible noise due to vibration of components.
 - 6. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Remote Damper Operators.
 - 1. Drive units: Where operators are associated with individual inlet or outlets, locate drive unit within associated grille or diffuser where appropriate. Otherwise, provide recessed wall/ceiling recessed drive units with cover plates.
 - 2. Coordinate location of actuator drive assembly with Architect.
- F. Control Dampers.
 - 1. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
 - 2. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact on performance.
 - 3. Unless specifically designed for vertical blade application, dampers mounted with blades horizontal.
 - 4. For duct-mounted and equipment-mounted dampers installed outside of equipment with flanged connections. Install in a visible and accessible indication of damper position from outside.
 - 5. Seal between damper frame and ductwork and between multiple damper sections to prevent leakage around perimeter of damper.
 - 6. Provide a minimum of one damper actuator per damper section.
 - 7. Seal penetrations made in fire-rated and acoustically rated assemblies.
 - 8. Service Access:
 - a. Dampers and actuators shall be accessible for visual inspection and service.
 - b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator.
- G. Turning Vanes.
 - 1. Install in mitered ductwork elbows and as shown on drawings.
 - 2. Install with leading and trailing edges parallel to entering and leaving airflow.
- H. Flexible Connectors.
 - 1. Install flexible connectors to connect ducts to equipment as shown on Drawings.
 - 2. Provide connectors at equipment connections for all equipment that has vibration isolation supports.
- I. Flexible Ductwork.
 - 1. Install in professional manner with straight sections that do not bend or sagging. Turning angle shall not exceed 30 degree unless supported by a Flexible Duct Elbow Support. Maximum length of 48-inches or as detailed on Drawings.
 - 2. Provide flexible duct for final connection to diffusers and grilles where shown on and as detailed on drawings.
 - 3. Do not use flexible ductwork for ASHRAE Class 3 or 4 exhaust air applications.
 - 4. Connect flexible ducts to metal ducts with tape and draw bands.
 - a. Tape inner duct liner to ductwork.
 - b. Secure inner duct liner with nylon draw strap.

- c. Secure outer liner with nylon draw strap.
- J. Automatic Balance Dampers:
 - 1. Install where indicated on Drawings.
- K. Test Holes.
 - 1. Install test holes at fan inlets and outlets, coil inlets and outlets, and elsewhere as indicated.

3.2 APPLICATION

- A. Manual Volume Dampers:
 - 1. Material: Volume damper construction frame and blade material shall match material of connected ductwork.
 - 2. Type:
 - a. Round/Oval Single Blade Manual Volume Dampers: All round ductwork 20-inch diameter and below.
 - b. Round Multiple Blade Manual Volume Dampers: All round ductwork greater than 20-inch diameter in exposed or concealed locations.
 - c. Rectangular Single Blade Manual Volume Dampers: Rectangular ductwork where largest cross-sectional dimension is 18-inches and below.
 - d. Rectangular Multiple Blade Manual Volume Dampers:
 - 1) Round or oval ductwork greater than 20-inch diameter located in concealed locations. Provide rectangular to round transition for connecting to round ductwork.
 - 2) Rectangular or oval ductwork where largest cross-sectional dimension greater than 18-inches. Provide rectangular to oval transition for connecting to oval ductwork.
- B. Control Dampers.
 - 1. Roof curb isolation dampers.
 - a. Damper Type: High Performance Control Dampers, Insulated.
 - b. Damper Width: 4-inch.
 - c. Blade Action: Opposed.
 - d. Blade Orientation: Parallel to longest dimension.
 - 2. Duct mounted isolation dampers.
 - a. Damper Type: High Performance Control Dampers, Insulated.
 - b. Damper Width: 6-inch.
 - c. Blade Action: Opposed.
 - d. Blade Orientation: Parallel to longest dimension.
 - 3. Actuators: Comply with 23 09 25 - BAS Field Mounted Devices for HVAC.
- C. Flexible Connectors.
 - 1. Indoor system: All indoor applications, except where otherwise required.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Inspect turning vanes for proper and secure installation.
4. Operate remote damper operators to verify full range of movement of operator and damper prior to covering work or limiting access for inspection.

END OF SECTION

SECTION 233416
CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Backward-inclined centrifugal fans.
 2. Square in-line centrifugal fans.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
 3. Certified fan performance curves with system operating conditions indicated.
 4. Certified fan sound-power ratings.
 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
- B. Shop Drawings:
1. Include plans, elevations, sections, and attachment details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

- A. Factory quality-control-report:
1. Fan Vibration Testing Report.
- B. Field quality-control reports.

1.4 FACTORY QUALITY CONTROL

- A. Vibration: Each fan shall be vibration tested before shipping, as an assembly, in accordance with AMCA 204-05. Each assembled fan shall be test run at the factory at the specified fan operating conditions. Vibration signatures shall be taken on each fan bearing in the horizontal, vertical, and axial directions. The maximum allowable fan vibration level at the design conditions when the fan is rigidly mounted shall be as follows:
1. Motor hp < 0.2: 0.5 in./sec. peak velocity.
 2. Motor hp > 0.2 and less than 5.0: 0.2 in./sec. peak velocity.
 3. Motor hp > 5.0 with spring isolation: 0.15 in./sec. peak velocity.
 4. Motor hp > 5.0 with neoprene mounts: 0.08 in./sec. peak velocity.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. AMCA Compliance:
 - 1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
 - 2. Operating Limits: Classify according to AMCA 99.

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. Twin City Blower.
- B. Description:
 - 1. Factory-fabricated, -assembled, -tested, and -finished, direct-driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 - 2. Factory-installed and -wired disconnect switch.
- C. Housings:
 - 1. Housing Material: Spun aluminum.
 - 2. Housing Coating: None.
 - 3. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories with welded connections.
 - 4. Housing Assembly: Sideplates continuously welded.
 - 5. Spun inlet cone with flange.
 - 6. Outlet flange.
- D. Wheels:
 - 1. SWSI construction with curved inlet flange.
 - 2. Heavy backplate.
 - 3. Backward inclined or as scheduled .
 - 4. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
 - 5. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
 - 6. Wheel and Blade Material: Aluminum.
 - 7. Wheel and Blade Coating: None.

- E. Shafts:
 - 1. Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 - 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

- F. Bearings:
 - 1. Self-aligning, pillow-block-type, Air Handling Quality, ball or roller bearings with adapter mount and two-piece, cast-iron housing. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.
 - 2. Bearings shall be fixed to the fan shaft using concentric mounting locking collars.
 - 3. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000 hours.
 - 4. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000 hours.

- G. Direct-Driven:
 - 1. Motor: Permanently lubricated, fully modulating, variable speed, electrically commutated or as scheduled on drawings. Comply with requirements in Section 230513 - Common Motor Requirements for HVAC Equipment.
 - 2. Motor Controller: As scheduled. Comply with requirements in 23 05 14 - Common Motor Control Requirements for HVAC Equipment.
 - 3. Arrangement 8 configuration.
 - 4. Fans shall have flexible coupling with the fan wheel connected to the fan drive shaft.

- H. Accessories:
 - 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 2. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 - 3. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

- I. Acoustic Performance.
 - 1. Sound power levels for fan assemblies shall be established in accordance with AMCA 300 and 310.
 - 2. Sound power levels (db) for assembled unit shall be established by testing or by calculation.
 - 3. Sound power levels for units and components shall not exceed values as scheduled on drawings:

2.3 SQUARE IN-LINE CENTRIFUGAL FANS, MAU-1

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. PennBarry.
 - 4. Twin City Blower.

- B. Description: Square in-line centrifugal fans.

- C. Housing:
 - 1. Housing Material: Reinforced steel.

2. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
 3. Insulation:
 - a. 1-inch- thick, unfaced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
- D. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.
- E. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
1. Motor: Permanently lubricated, fully modulating, variable speed, electrically commutated or as scheduled on drawings. Comply with requirements in Section 230513 - Common Motor Requirements for HVAC Equipment.
 2. Motor Controller: As scheduled. Comply with requirements in 23 05 14 - Common Motor Control Requirements for HVAC Equipment.
 3. Vibration isolation: Neoprene mounting.
- F. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 2. Companion Flanges: For inlet and outlet duct connections.
- G. Filter and Filter Housing:
1. 2-inch side access holding frame with hinged access door or sliding end plate. Side or bottom opening as required.
 2. Filter and air filter frames provided hereunder: Type: F- 1. Comply with requirements in 23 41 00 "Particulate Air Filtration".
 3. Insulation:
 - a. 1-inch- thick, unfaced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 4. Insulated, hinged access panels for filter section.
- H. Acoustic Performance.
1. Sound power levels for fan assemblies shall be established in accordance with AMCA 300 and 310.
 2. Sound power levels (db) for assembled unit shall be established by testing or by calculation.
 3. Sound power levels for units and components shall not exceed values listed below:
 - 4.

Frequency	63	125	250	500	1000	2000	4000	8000
MAU-1								
Fan inlet	78	86	79	72	71	72	72	71
Fan outlet	95	89	79	77	77	75	74	72
Fan radiated	76	81	69	65	63	60	62	61

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install centrifugal fans level and plumb.

- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
 - 1. Install floor mounted centrifugal fans on cast-in-place concrete equipment housekeeping pads or as detailed on drawings.
 - 2. Install roof-mounted centrifugal fans on roof curbs or as otherwise detailed on drawings. Comply with requirements in 23 05 00 - General HVAC Provisions, Roof Curbs, Bases, and Rails without integral vibration Isolation.
 - 3. Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Section 230529 - Hangers and Supports for HVAC Piping and Equipment.
 - 4. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 - Vibration and Seismic Controls for HVAC.
- E. Install units with clearances for service and maintenance.

3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories.
- B. Install ducts adjacent to fans to allow service and maintenance.

3.3 STARTUP SERVICE:

- A. Perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
 - 6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 7. Adjust belt tension.
 - 8. Adjust damper linkages for proper damper operation.
 - 9. Verify lubrication for bearings and other moving parts.
 - 10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 11. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.

- D. Comply with requirements in Section 230593 - Testing, Adjusting, and Balancing for HVAC.

3.5 CLEANING

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
 1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Operate fan through full speed control range. Note any frequencies where excessive vibration occurs. Adjust motor controller to remove frequencies with excessive vibration. Refer to 23 05 14 - Common Motor Control Requirements for HVAC Equipment.
 4. Fans and components will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 234100

PARTICULATE AIR FILTRATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Flat panel filters.
 - 2. Pleated panel filters.
 - 3. Filter gages.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
- B. Product Test Reports: For each filter, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each filter, for tests performed by a qualified testing agency.
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIALS SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide two complete set(s) of filters for each filter bank. Filters shall be clean at date of Substantial Completion. Filters furnished herein shall be in addition to those provided to replace filters used during construction.

1.6 QUALITY ASSURANCE

- A. ASHRAE Compliance:
 - 1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
 - 2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.
- B. Comply with NFPA 90A and NFPA 90B.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean, dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
 - 1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
 - 2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
- E. Replace installed products damaged during construction.

PART 2 PRODUCTS

2.1 PLEATED PANEL FILTERS

- A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. AAF/Flanders.
 - b. Camfil Farr.
 - c. UL Class establishes smoke and flammability limits according to two classifications. Class 1 is essentially non-flammable and produces negligible smoke. Class 2 filters burn moderately and smoke moderately. Class 2 filters meet mechanical code for HVAC systems and are the SWE standard. Class 1 would be selected only for special applications where smoke could damage the area served. If Class 1 is selected, the spec writer should review the spec to make sure it works.
- B. Filter Unit Class: UL 900, Class 2.
- C. Media: Cotton and synthetic fibers coated with nonflammable adhesive.
 - 1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - 3. Media shall be coated with an antimicrobial agent.
 - 4. Separators shall be bonded to the media to maintain pleat configuration.
 - 5. Welded wire grid shall be on downstream side to maintain pleat.
 - 6. Media shall be bonded to frame to prevent air bypass.
 - 7. Support members on upstream and downstream sides to maintain pleat spacing.
- D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

- E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
- F. Capacities and Characteristics:
 - 1. Designation: F-1.
 - a. Face Dimensions: As required to accommodate filter frame or housing.
 - b. Depth: 2 inch or 4 inch as required to match filter housing.
 - c. Initial Pressure Drop: 0.33-inches w.g. at 500 fpm.
 - d. Final Resistance: 1 inch-w.g. at 500 fpm.
 - e. Maximum Rated Pressure Drop: 2-inches w.g.
 - f. MERV Rating: 8 when tested according to ASHRAE 52.2.

2.2 FILTER GAGES

- A. Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment. Gages located outdoors shall have waterproof enclosure and sun shield.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Dwyer Instruments, Inc.
- B. Size and Scale.
 - 1. Diameter: 4-1/2 inches.
 - 2. Scale Range:
 - a. Filter Final Resistance of 0.5-Inch wg and Less: 0 to 0.5-inch wg.
 - b. Filter Final Resistance of 0.5 to 1.0-Inch wg: 0 to 1.0-inch wg.
- C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Sizing:
 - 1. Select filter frames and housing to allow use of standard, readily available filter sizes.
 - 2. Metric size filters not acceptable.
- B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- C. Install filters in position to prevent passage of unfiltered air.
- D. Install filter gage for each filter bank.
- E. If permanently installed air handlers and air distribution system are used during construction, MERV 8 filtration media shall be installed at each return-air grille. Filters in air handlers used during construction shall have a minimum MERV 13 rating for systems that deliver air to occupied spaces or through air coils or heat exchangers.
- F. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- G. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from

filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position.

- H. Coordinate filter installations with duct and air-handling-unit installations.
- I. Filters shall fit in racks without bending, distortion, or modification.

3.2 APPLICATION

- A. List specific locations where field installed filter frame are provided or schedule on drawings.
- B. Provide filters and racks in equipment and in terminal devices as specified and as shown on drawings.

3.3 FIELD QUALITY CONTROL

- A. Retain paragraphs below to require a factory-authorized service representative to perform inspections, tests, and adjustments.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. Test for leakage of unfiltered air while system is operating.
- D. Air filter will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.4 CLEANING

- A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

SECTION 235130
VENT AND CHIMNEYS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Gas Vents.
 - 2. Sectional Chimneys.

1.2 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Design chimney system to vent equipment as shown on drawings including chimney size, routing, fittings and transitions, connections, terminations, accessories, and supports and attachments. Size and routing shown on drawings is approximate.
 - 2. Perform expansion calculations for systems having operating temperatures greater than 200oF. Design anchors, guides, and expansion joints as required to maintain acceptable forces on system components.
 - 3. Design venting system to drain condensation and rainwater that enters the system. Provide drains a low point and at the base of vertical risers more than 20 feet in elevation.
 - 4. Coordinate size, routing, fittings, and accessories with manufacturer of connected equipment to ensure that the completed installation is in conformance with requirements of connected equipment to obtain specified performance.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.
- B. Shop Drawings: For vents and chimneys.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly of hangers and seismic restraints.
 - 4. Provide performance calculations including entering and leaving stack temperatures and pressures.
 - 5. Provide expansion calculations where required and indication required anchors, guides, and expansion joints.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Approval of heating equipment manufacturer for using of listed vent or chimney systems with connected heating equipment.
- C. Sample Warranty: For special warranty.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in stacks.
- B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, structural failures caused by expansion and contraction.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GAS VENTS

- A. Listed High Efficiency Double Wall Appliance Vent.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Heatfab Saf-T Vent.
 - b. Metal-Fab, Inc.
 - c. Selkirk Corporation; DuraVent.
 - 2. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211.
 - 3. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.
 - 4. Inner Shell: ASTM A959, Type 29-4C stainless steel.
 - 5. Outer Jacket: Aluminized or stainless steel.
 - 6. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 7. Termination: Discharge cone.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Listed High Efficiency Single Wall Appliance Vent: Provided for condensing heating equipment where approved by heating equipment manufacturer.
 - 1. Listed High Efficiency Double Wall Appliance Vent.

3.3 INSTALLATION OF LISTED CHIMNEYS

- A. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish. Sectional chimneys shall be sealed watertight.
- C. Lap joints in direction of flow.
- D. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.
- E. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom. Slope horizontal sections toward suitable drainage point at slope of 1/4" per foot or as recommended by the manufacturer.
- F. Pipe drains to suitable drainage fixture with appropriate condensate trap and acid neutralizer as required.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
- B. Provide temporary closures at ends of chimneys and stacks that are not completed or connected to equipment.

END OF SECTION

SECTION 235216
CONDENSING BOILERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Packaged condensing type heating water boiler.

1.2 DESIGN REQUIREMENTS

- A. Equipment performance calculated for actual project elevation.
- B. Clearance to Combustibles: UL Listing for zero side wall clearance.

1.3 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
 1. Materials List.
 2. Catalog Data.
 3. Product Data.
 4. Performance Data.
 5. Wiring Diagrams.
 6. Shop Drawings.
 7. Installation Instructions.
 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Condensing hot water boiler			X	X	X	X	X	X

- B. Special Requirements:
 1. Boiler and burner manufacturer shall review complete flue system from boiler flue gas outlet to stack outlet to atmosphere and provide written approval of stack design with comments identifying any changes required to meet performance requirements and necessary measurement ports or other components needed for boiler start-up, tuning, and operation.
 2. Wiring Diagrams: Provide complete wiring diagrams indicating all wiring completed under this section including operating controls, burner controls, safety controls, and field wiring for all items of equipment and the system as a whole. Differentiate between manufacturer and field installed wiring.
 3. Provide factory test reports. Indicate and interpret test results to verify conformance with performance requirements before shipping.

1.4 QUALITY ASSURANCE

- A. Coordinate the entire assembly of boiler, boiler trim, burner, fuel trains including gas pressure regulators, burner control and flame safeguard, control system, emergency shutdown switch, breeching, and stacks.

1.5 PROJECT CONDITIONS

- A. Fuels to be Fired, Main Burner: Natural gas.
- B. Natural Gas: Furnished by local utility. Higher Heating Value is reported as 1,050 Btu per cubic foot at base pressure and temperature.
- C. Combustion Air: 80° F, 0.013 lbs. moisture per lb. dry air.
- D. Maximum supply water temperature: 200oF.
- E. Maximum heating water system pressure: 125 psig.

1.6 ADDITIONAL WARRANTY

- A. 20-year, non-prorated warranty for damage due to thermal shock.

PART 2 PRODUCTS

2.1 PERFROMANCE REQUIREMENTS

- A. Short Circuit Current Rating (SCCR): SCCR ratings of equipment shall be equal to or greater than the available fault current indicated on the electrical one-line diagrams and panel schedules or as otherwise indicated whichever is greater. Alternatively, where no fault rating is available on electrical drawings, the SCCR of equipment shall be 65kA or as approved by Engineer.

2.2 CONDENSING HOT WATER BOILER

- A. Acceptable Manufacturers: Lochinvar, RBI, or approved.
- B. General: Gas-fired, condensing water tube design with positive discharge pressure. Self-supporting, baffle free, helical fire tube heat exchanger, warranted to withstand thermal shock. UL listed.
- C. Heat Exchanger: Stainless steel primary and secondary heat exchangers.
 - 1. Inspection openings: In accordance with ASME Section IV pressure vessel code.
 - 2. Rated Pressure: ASME stamped for a working pressure not less than 150 psig.
- D. Combustion Chamber: Stainless steel, sealed.
- E. Burner: Cast stainless steel burner head. All burner materials exposed to the combustion zone shall be of stainless-steel construction. Minimum 10:1 turndown.
- F. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.
- G. Fuel Train: UL listed, ASME CSD-1 approved.
- H. Safety Valves: Provide one or more on each boiler. Conform to ASME Boiler and Pressure Vessel Code, Section IV.
- I. Minimum Efficiency Performance as scheduled on Drawings.

- J. Boiler Controls:
 1. Boiler supply water temperature control.
 2. Burner flame safeguard system.
 3. Remote discharge temperature reset from Building Management System.
 4. Electric probe-type low water cutoff and dual over-temperature protection including manual reset in accordance with ASME CSD-1.
 5. Remote fault alarm contacts and sensor failure detection.
 6. Message annunciation.
 7. Fault diagnostic display.
 8. Internal "Cascade" function with capability to operate lead-lag functionality and efficiency optimization.
 9. BacNet MSTP remote connectivity.

- K. Electrical.
 1. As scheduled on Drawings.

- L. Boiler venting:
 1. Outlet Venting: Provided hereunder. See section 23 5130 Vent and Chimneys.
 2. Combustion air: Re-use existing venting.

- M. Accessories:
 1. Emergency Shutoff Switch:
 - a. Acceptable Manufacturer: Safety Technology International, Inc.
 - b. Similar to Stopper II.
 - c. Manual reset.
 - d. Provide label indicating "Boiler Emergency Shutoff.
 - e. Color: red.

- N. Condensate Neutralizer:
 1. Rectangular PVC container with limestone media in-line with condensate drain, sized for peak boiler condensate flow. Removable water-tight cover or opening suitable for media change-out, without removing neutralizer from piping.
 2. Provide additional limestone media, sufficient for two future change-outs.

PART 3 EXECUTION

3.1 BOILER INSTALLATION

- A. Install as shown on Drawings and in accordance with manufacturer's recommendations.
- B. Access: Arrange all equipment and piping to allow access for normal service without disassembly of equipment or piping.
- C. Provide boiler condensate drain from exhaust manifold connection to floor drain. Size in accordance with manufacturer's recommendation.

3.2 BOILER SETUP AND SEQUENCING

- A. Boiler Sequence:
 1. Boiler controller responds to BAS for boiler plant sequencing and control, subject to safeties and integral operational delays.
 2. The boiler controller shall:
 - a. Sequence the boilers in lead/lag configuration, alternating weekly.
 - b. Control firing rates to maintain heating water setpoint to maintain heating water

- temperature setpoint with minimum boiler ON/OFF cycles.
- c. Indicate which boiler is the lead boiler to the BAS.
- d. Announce boiler system alarms to the BAS.
- e. Activate boilers and control firing rates.
- f. Modulate burners in unison when both boilers are firing,
- g. Start and stop associated boiler pumps.
- 3. The BAS (working in conjunction with the boiler controller) shall:
 - a. Enable boiler system in response to building heating requirement and outside air temperature:
 - b. Determine and signal heating water setpoint.
 - c. Monitor operating status of each boiler.

3.3 BOILER PLANT EMERGENCY SHUTDOWN

- A. Provide emergency shutoff switch at every entry door to boiler room in accordance with ASTM CSD-1. Provide conduit, wiring and contactor in accordance with Division 26 as necessary to shut off all power to boiler when switch is activated.

3.4 BOILER START-UP

- A. Manufacturer's certified representative to provide the following services:
 - 1. Inspect boiler after installation to ensure boiler installation is in accordance with manufacturer's recommendation.
 - 2. Supervise initial start-up.
 - 3. Provide minimum 4 hours of training, including operation and maintenance. Coordinate schedule with Owner.
 - 4. Adjust burner to obtain specified performance and combustion efficiency. Perform efficiency tests. Submit test report to Engineer within seven days of startup.
 - 5. Test boiler safety control devices. Complete and submit ASME CSD-1 form CG-500 to engineer within seven days of startup.
- B. Perform initial boil-out of boiler according to manufacturer's recommendations. Provide chemicals, temporary piping, and facilities necessary for work as required.

END OF SECTION

SECTION 236500
COOLING TOWERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Section includes factory-assembled, closed-circuit, induced draft, crossflow cooling towers.

1.2 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
 1. Materials List.
 2. Catalog Data.
 3. Product Data.
 4. Performance Data.
 5. Wiring Diagrams.
 6. Shop Drawings.
 7. Installation Instructions.
 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Closed circuit cooling tower			X	X	X	X	X	X

Special Requirements: Recommended structural steel support arrangement, including dimensions, sizes, and locations for mounting bolt holes. Include weight distribution drawings showing point loadings.

- B. Product Data: For each type of product.
 1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
 2. Maximum flow rate.
 3. Minimum flow rate.
 4. Pressure required at cooling tower supply piping connections.
 5. Drift loss as percent of design flow rate.
 6. Volume of water in suspension for purposes of sizing remote storage.
 7. Sound:
 - a. Sound pressure levels for operation with fan at design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.
 - b. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and design speed.
 8. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percent of brake horsepower).
 9. Fan motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
 10. Pump flow rate, head, brake horsepower, and efficiency.
 11. Pump motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent

- of nameplate horsepower.
12. Electrical power requirements for each cooling tower component requiring power.

1.3 INFORMATIONAL SUBMITTALS

- A. Factory quality-control-report:
1. Fan Vibration Testing Report.

1.4 FACTORY QUALITY CONTROL

- A. Vibration: Each fan shall be vibration tested before shipping, as an assembly, in accordance with AMCA 204-05. Each assembled fan shall be test run at the factory at the specified fan operating conditions. Vibration signatures shall be taken on each fan bearing in the horizontal, vertical, and axial directions. The maximum allowable fan vibration level at the design conditions when the fan is rigidly mounted shall be as follows:
1. Motor hp < 0.2: 0.5 in./sec. peak velocity.
 2. Motor hp > 0.2 and less than 5.0: 0.2 in./sec. peak velocity.
 3. Motor hp > 5.0 with spring isolation: 0.15 in./sec. peak velocity.
 4. Motor hp > 5.0 with neoprene mounts: 0.08 in./sec. peak velocity.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.
- B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.
1. Clearly label each separate package with a unique designation and include with assembly instructions for each complete cooling tower.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Baltimore Aircoil Company.
 2. EVAPCO, Inc.
 3. Marley Cooling Technologies; SPX Cooling Technologies.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Cooling tower and support structure shall withstand the effects of loads and stresses within limits and under conditions indicated according to governing code.
- B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. Operation Following Loss of Normal Power:
 - 1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
 - 2. Include means and methods required to satisfy requirement even if not explicitly indicated.
- E. Vibration:
 - 1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry-standard requirements for cooling towers.
 - 2. Critical speed shall be at least 115 percent of design speed.
- F. Short Circuit Current Rating (SCCR): SCCR ratings of equipment shall be equal to or greater than the available fault current indicated on the electrical one-line diagrams and panel schedules or as otherwise indicated whichever is greater. Alternatively, where no fault rating is available on electrical drawings, the SCCR of equipment shall be 65kA or as approved by Engineer.

2.3 DESIGN ARRANGEMENT

- A. Crossflow design with airflow from side air entry, vertical air discharge, and induced-draft, bottom-mounted centrifugal fans.

2.4 CASING AND FRAME

- A. Casing Material: Galvanized steel, ASTM A 653/A 653M, G235 coating and Polymer-coated galvanized steel.
- B. Frame Material: galvanized steel, ASTM A 653/A 653M, G235 coating and polymer-coated galvanized steel.
- C. Hardware: Galvanized-steel.
- D. Joints and Seams: Sealed watertight.
- E. Welded Connections: Sealed watertight by continuous welds.

2.5 COLLECTION BASIN

- A. Factory-Assembled Collection Basin:
 - 1. Material: Galvanized steel, ASTM A653/A653M, G235 (Z700) coating.
 - 2. Hardware: Galvanized steel.
 - 3. Joints and Seams: Sealed Watertight.
 - 4. Welded Connections: Sealed watertight by continuous welds.
 - 5. Removable corrosion resistant strainer with openings smaller than nozzle orifices.
 - 6. Overflow and drain connections.
 - 7. Makeup-water connection.
 - 8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
 - 9. Basin Sweeper Distribution Piping and Nozzles:
 - a. Pipe Material: PVC or CPVC, Schedule 40 or heavier, treated with UV inhibitors and intended for continuous exposure to direct sunlight with degradation.
 - b. Nozzle Material: Plastic.

- c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.
- d. Basin penetrations sealed watertight.
- e. Field Connections: Threaded or flanged depending on pipe size. Thread for sizes through 2" and flanged for larger sizes.

2.6 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

- A. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

2.7 COLLECTION BASIN HEATER

- A. Electric Heater:
 1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
 2. Heater Control Panel: Factory installed Provide independent control panel for each cell.
 - a. Enclosure: NEMA 250, Type 3R, Type 4, or Type 4X.
 - b. Single-point, field-power connection to a fused disconnect switch.
 - c. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
 - d. Control-circuit transformer with primary and secondary side fuses.
 - e. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
 - f. Single-point, field-power connection complying with NFPA 70.
 3. Cooling Tower Control Devices: Provide factory install temperature sensor/controller to maintain collection basin water-temperature set point and water-level probe to monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.

2.8 GRAVITY WATER DISTRIBUTION BASIN

- A. Design: Non-pressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.
 1. Material: Stainless-steel, Grade 304.
 2. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
 3. Inlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
 4. Fasteners: Stainless-steel.
 5. Joints and Seams: Sealed watertight.
 6. Welded Connections: Sealed watertight.
 7. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable corrosion-resistant or stainless-steel hardware. Panels reinforced to accommodate service personnel walking on the panels without resulting in permanent deflection and damage.
 8. Single-Inlet, Field Pipe Connection: PVC pipe arranged to achieve balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the side unless otherwise indicated.

2.9 FILL

- A. Materials: PVC, with maximum flame-spread index of 5 according to ASTM E 84.

- B. Minimum Thickness: 15 mils, before forming.
- C. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
- D. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.
- E. Hardware: Galvanized steel.

2.10 HEAT-EXCHANGER COILS

- A. Tube and Tube Sheet Materials: carbon-steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication.
- B. Heat-Exchanger Arrangement:
 - 1. Serpentine tubes; sloped for complete drainage of fluid by gravity.
 - 2. Tubes with extended surface fins if required to achieve performance indicated.
- C. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; sloped for complete drainage of fluid by gravity.
- D. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange.

2.11 DRIFT ELIMINATORS

- A. Material: PVC; with maximum flame-spread index of 25 according to ASTM E84.
- B. Arrangement: Multiple, easily removable sections.
- C. Configuration: Multi-pass, designed and tested to reduce water carryover to 0.005 percent of design flow rate indicated.
- D. Hardware: Galvanized steel.

2.12 AIR INLET

- A. Air-Intake Opening.
 - 1. Polymer-coated, galvanized-steel wire mesh with openings of size sufficient to not restrict airflow or impact performance for air duct connection.
 - 2. Segmented into manageable individual sections arranged to facilitate independent removal of each section without disturbing adjoining sections.
- B. Hardware: Galvanized steel.

2.13 FAN AND DRIVE ASSEMBLY

- A. Fans: Forward curved centrifugal fans. Statically and dynamically balanced. Steel fan shaft with two-part epoxy coating for corrosion protection. Fan wheel, housing, inlet rings, and discharge cowls constructed of same material as structural elements.
 - 1. Bearings: Air handler quality, self-aligning, grease lubricated, pillow block, selected for a minimum L10 life of 200,000 hours at maximum cataloged operating conditions in accordance with ABMA-9. Grease fittings extended to accessible location near

- access door.
2. Drive and Belts: Provide hereunder V-Belt, Cast-Iron Sheave, See Section 23 05 31 - V-Belts and Sheaves. Provide adjustable sheave on motors 15 hp and less. Provide metal belt guards as required by OSHA. Provide belt guards with openings for fan tachometer readings and sized to allow either sheave to be increased two sizes.
 3. Balancing: Statically and dynamically balance fan section assemblies including fan wheels, shafts, bearing, drives, belts, isolation bases, and isolators.
- B. Belt Drive:
1. Service Factor: 1.5 based on motor nameplate horsepower.
 2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
 3. Belt: Multiple V or multi-grooved belt design with a matched set of belts.
 4. Belt Material: Oil resistant, non-static conducting, and constructed of neoprene polyester cord.
 5. Belt-Drive Guard: Comply with OSHA regulations.
- C. Fan Motor:
1. Motor: Provided hereunder, see Section 230513 - Common Motor Requirements for HVAC Equipment.
 2. Variable Frequency Drives: Provided hereunder, refer to Section 23 05 14 - Motor Control Devices for HVAC Equipment.
 3. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
 4. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
 5. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.
- D. Hardware: Galvanized steel.

2.14 AIR DISCHARGE

- A. Fan Discharge Stack:
1. Manufacturer's standard low-profile design.
 2. Material: Material to match casing.
 3. Stack Termination: Wire-mesh, polymer-coated, galvanized-steel screens; segmented into multiple removable pie sections and complying with OSHA regulations for duct connection.
- B. Hardware: Galvanized steel.

2.15 RECIRCULATING WATER DISTRIBUTION SYSTEM

- A. Pump: Close-coupled, single-stage, bronze-fitted centrifugal pump; with mechanical seal and suitable for outdoor service. Factory install pump with the following:
1. Redundant Pump: Same performance as required for primary pump; easily switched and maintained while cooling tower remains operating.
 2. Flanges at pump connections to piping.
 3. Strainer, with blowdown isolation valve, installed in piping on suction side of pump.
 4. Anti-vortexing baffles to prevent air entrainment.
 5. Flow balancing valve in piping on discharge side of pump.

- B. Pump Motor:
 1. Motor: Provided hereunder, see Section 230513 - Common Motor Requirements for HVAC Equipment.
 2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- C. Piping: Interconnecting collection basin to pump and pressurization distribution system.
 1. Design delegated to manufacturer.
 2. External to and supported from cooling tower casing and frame.
 3. Material: PVC.
 4. Install flanges at connections to collection basin and pressurized distribution system.
 5. Drain connection with isolation valve at piping low point if piping does not drain directly into collection basin.
- D. Piping: Field installed for connection to remotely installed pump and water storage that are not furnished with cooling tower.

2.16 ELECTRICAL POWER

- A. Factory Furnish for Field Installation: A variable-frequency controller for each fan motor and a motor starter for each pump motor.
- B. Factory Install: A disconnect switch for each fan motor and a disconnect switch for each pump motor.
 1. Locate in a convenient and field-accessible location within sight of motor.
 2. Installation shall comply with NFPA 70.
 3. Wire, Conduit, and Enclosures:
 - a. Minimum Conduit Size: 0.75 inch.
 - b. Materials: Corrosion resistant.
 - c. Motor Termination: Liquidtight conduit, not to exceed 36 inches long.
 - d. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware.
 - e. Wire:
 - 1) Copper, rated for 600-V, solid wire for size No. 10 AWG and smaller and stranded wire for larger sizes.
 - 2) Minimum Wire Size: No. 12 AWG.
 - 3) Each circuit shall have a ground wire.
 - 4) Install wire in conduit.
 - f. Boxes, Condulets, and Enclosures: NEMA 250, Type 4.
- C. Disconnect Switches:
 1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
 2. Three pole, nonfused.
 3. 600-V rated.
 4. Minimum short-circuit current rating (SCCR) shall be as required by electrical power distribution system, but not less than 10,000 A.
 5. Enclosure: NEMA 250, Type 4.
 6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
 7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
 8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning

- switch "ON" when the door is open.
 - 9. Include a solid neutral as required by authorities having jurisdiction.
 - 10. Include a ground lug for ground wire termination.
 - 11. Operating handle shall be lockable in open position.
 - 12. Horsepower rated.
 - 13. Feed through or double lugged.
- D. Motor Controllers: Motor starters, Variable Frequency Drives provided hereunder. Refer to Section 230514 - Motor Control Requirements for HVAC Equipment.

2.17 CONTROLS

- A. Vibration Switch: For each fan drive.
1. Enclosure: NEMA 250, Type 4.
 2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
 3. Switch shall have manual-reset button with hardwired connection to fan motor electrical circuit.
 4. Switch shall have field connection for hardwired connection to control system.
 5. Switch shall, on sensing excessive vibration, signal an alarm for connection to control system and shut down the fan.
- B. Control Package:
1. Factory installed and wired, and functionally tested at factory before shipment.
 2. NEMA 250, Type 4 enclosure with removable internally mount backplate.
 3. Control-circuit transformer with primary and secondary side fuses.
 4. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
 5. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
 6. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
 7. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Collection Basin Heater" Article.
 8. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
 9. F field-power connection to a nonfused disconnect switch.
 - a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
 - b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
 10. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
 11. Visual indication of status and alarm for each motor.
 12. Audible alarm and silence switch.
 13. Visual indication of elapsed run time, graduated in hours for each motor.
 14. Cooling tower shall have hardware to enable control system to remotely monitor and display the following:
 - a. Operational status of each motor.
 - b. Cooling tower leaving-fluid temperature.
 - c. Fan vibration alarm.
 - d. Collection basin low-water-level alarms.

2.18 CAPACITIES AND CHARACTERISTICS

- A. Performance as scheduled on Drawings and as listed below.
- B. Air-Inlet Arrangement: One side.
- C. Sound Pressure Level at 50 feet when measured according to CTI ATC 128:
 - 1. Top: 60 dB.
 - 2. Ends: 55 dB.
 - 3. Air Inlet: 62 dB.
- D. Collection Basin Heater: As scheduled on Drawings.

2.19 SOURCE QUALITY CONTROL

- A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS, "Standard for the Certification of Water-Cooling Tower Thermal Performance."
 - 1. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- B. Factory Functional Tests:
 - 1. Test collection and distribution basins after assembly, and prove free of leaks.
 - 2. Test factory-installed electric/electronic water-level controls for proper operation.
 - 3. Test factory-installed electric basin heaters for proper operation.
 - 4. Test factory-installed fan and drive assemblies for proper operation.
 - 5. Test factory-installed control package for proper operation.
 - 6. Test access doors to ensure smooth operation and proper fit.
 - 7. Submit report documenting tests performed and results within one week of test date.
- C. Heat-Exchanger Factory Pressure and Leak Tests:
 - 1. Pneumatically test heat-exchanger assembly while submerged underwater and prove to be free of leaks.
 - 2. Test pressure equal to 1.5 times rated pressured, but not less than 300 psig.
 - 3. Submit report documenting test and results.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install as shown on Drawings and in accordance with manufacturer's recommendations.
- B. Provide unions for piping connections which do not have flanged or mechanical joint connections.
- C. Provide test plugs adjacent to condenser water inlet and outlet connections.
- D. Level and overflow piping routed full size to approved drainage fixture.
- E. Install shutoff valve and drain valve for make-up water piping in suitable heated space to allow water to be drained from section located in non-heated locations.
- F. Perform chemical treatment and passivation as specified, see Section - 23 25 13 - Water Treatment for Hydronic Systems.

3.2 INSPECTION

- A. Inspect unit for to corrosion protection coatings. Repair damaged coatings as recommended by manufacturer.
- B. Inspect to ensure that the unit is installed will adequate clearance at inlet openings and at discharge in accordance with manufacturer recommendations to ensure proper airflow and to prevent recirculation.
- C. Equipment Start-up Checks.
 - 1. Verify shipping blocks and bracing have been removed.
 - 2. Verify that unit is mounted to structural support system as detailed on Drawings and as recommended by the equipment manufacturer.
 - 3. Verify unit surfaces are clean and debris is removed from fans and basin.
 - 4. Verify motor rotation direction.
 - 5. Verify that fan wheel rotates freely and the bearing operation is smooth.
 - 6. Verify lubrication of bearing and other rotating parts.
 - 7. Verify belt alignment and tension.
 - 8. Verify operation of sump level switch and temperature switch where provided.
 - 9. Verify that automatic volume control dampers are fully open.
 - 10. Verify that water distribution nozzles have flow and evenly distribute water over media. Adjust nozzles as required.
 - 11. Verify that proper thermal overload protection devices and settings are adjusted for variable frequency drives, starters, and disconnect switches. Adjust overload settings for fan motor rated load amperage.
 - 12. Energize fan motor and measure and record motor voltage and amperage.
- D. Adjust sump heater temperature setpoint to 45°F.

3.3 MANUFACTURER'S FIELD SERVICE

- A. Manufacturer's certified representative to provide following services:
 - 1. Inspect tower after installation is complete. Complete manufacturers installation and start-up report and submit copy to Engineer certifying tower installation and operation is in accordance with manufacturer's recommendation.
 - 2. Supervise initial start-up.
 - 3. Provide minimum 4 hours of training including operation and maintenance. Coordinate training time with Owner's Authorized Representative minimum 14 days prior to training. Training shall be performed after Substantial Completion and will not occur on the same day as equipment start-up.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Operate fan through full speed control range. Note any frequencies where excessive vibration occurs. Adjust motor controller to remove frequencies with excessive vibration. Refer to 23 05 14 - Common Motor Control Requirements for HVAC Equipment.

END OF SECTION

SECTION 237223

PACKAGED AIR-TO-AIR ENERGY-RECOVERY UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Packaged energy recovery units with integral energy recovery wheels for indoor outdoor installation.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: Two set(s) of belts for each belt-driven fan in energy recovery units.
 - 2. Wheel Belts: Two set(s) of belts for each heat wheel.

1.5 COORDINATION

- A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Greenheck, or approved.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- C. ASHRAE Compliance:
 - 1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. AHRI Compliance:
 - 1. Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
- F. UL Compliance:
 - 1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
- G. AATCC30 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.3 ENERGY RECOVERY HEAT WHEELS

- A. General:
 - 1. Energy recovery wheel shall transfer sensible and latent energy between outgoing and incoming air streams in a counter flow arrangement.
 - 2. Wheel shall be oriented in the vertical direction.
 - 3. Energy recovery wheel designed for a maximum rotational speed of 20 rpm.
- B. Casing:
 - 1. Steel with standard factory-painted finish or aluminum.
 - 2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
 - 3. Casing labeled for rotation direction and airflows.
- C. Rotor: Polymer material with silica gel desiccant permanently bonded. Segmented wheel with separately removable sections in galvanized steel framework.
 - 1. Corrugation pattern of closed triangular shape to limit cross-leakage between airstreams.
- D. Seals:
 - 1. Labyrinth seals facing media and along periphery. Polymer contact seal along depth of wheel. Zero gap between seal and media. Adjustable seals.
 - 2. Seals Rating: 12-inch w.c. pressure difference.
- E. Drive Assembly:
 - 1. Bearings: Support rotor on pillow block bearings replaceable without removal of the rotor from the casing or media from its spoke system. Extend grease fittings to acceptable location. Bearing rating minimum L10-500,000.
 - 2. Rotor shaft: stainless steel.
 - 3. Belts: Self-adjusting multilink belt around outside of rotor.
 - 4. Motor: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller.

- a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in 23 05 13 - Common Motor Requirements for HVAC Equipment.
 - b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - c. Motor Safety Factor: minimum 2.6.
- F. Electrical:
- 1. Factory installed and wired, and functionally tested at factory before shipment.
 - 2. Enclosure: Unit mounted, NEMA 250, Type 1.
 - 3. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
 - 4. Means of electrical disconnect.
 - 5. Energy Recovery Wheel Variable Frequency Drive: Manufacturer's standard, capable of modulating wheel speed for leaving temperature control and defrost and perform control functions specified.
 - a. Motor and drive combinations shall allow for turndown ratio of 80:1 (20 rpm to 0.25 rpm).
- G. Controls:
- 1. General: Factory furnished control interface for control and monitoring by BAS.
 - 2. Control and Monitoring Functions:
 - a. Pilot-Light Indicator: Display rotor rotation and speed.
 - b. Temperature monitoring of four entering and leaving air temperature sensors for communication to BAS.
 - c. Frost Control: Modulate VFD wheel speed to maintain the exhaust temperature above set point of 34°F, adjustable.
 - d. Economizer Mode: When outdoor air temperature is below the return air temperature, modulate VFD wheel speed to prevent the supply temperature from exceeding the desired supply air temperature set point of 60°F, adjustable.
 - e. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
 - 3. BAS Interface: Factory install hardware and software to enable system to monitor, control, and display VFD status and alarms.
 - a. Hardwired I/O Points:
 - 1) Control:
 - a) On-off operation.
 - b) Remote speed command.
 - c) Remote temperature setpoint adjustment.
 - 2) Monitoring:
 - a) On-off motor status.
 - b) Outside air entering temperature.
 - c) Return air entering temperature.
 - d) Supply air leaving temperature.
 - e) Exhaust air leaving temperature.
 - 4. BAS Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor unit.
 - a. Control features and monitoring points displayed locally at unit control panel shall be available through the control system, including, as a minimum, the following:
 - 1) Control:
 - a) On-off operation.
 - b) Remote speed command.
 - c) Remote temperature setpoint adjustment.
 - 2) Monitoring:
 - a) On-off motor status.
 - b) Outside air entering temperature.
 - c) Return air entering temperature.

- d) Supply air leaving temperature.
- e) Exhaust air leaving temperature.

2.4 PACKAGED ENERGY RECOVERY UNITS

- A. General:
 - 1. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Housing: Manufacturer's standard construction, minimum 18 gauge, galvanized G90 sheet metal. Finished with corrosion-protection coating and exterior finish, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 2-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.
- C. Outside Air and Exhaust Air Isolation Dampers:
 - 1. Low-Leakage, Isolation Dampers: Double-skin, airfoil-blade, aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed-blade arrangement with steel operating rods rotating in stainless-steel sleeve or sintered bronze or nylon bearings mounted in a single aluminum frame, with operating rods connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.
 - 2. Isolation Dampers: Opposed-blade, galvanized-steel dampers with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame with operating rods connected with a common linkage, and electric damper operator factory wired. Blades shall have gaskets and edge seals, and shall be mechanically fastened to operating rod.
- D. Heat Recovery Device: Heat wheel.
- E. Supply and Exhaust Fans: Forward-curved, centrifugal fan with neoprene isolation devices flexible duct connections.
 - 1. Motor and Drive: Belt driven, motor mounted on adjustable base.
 - 2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in 23 05 13 - Common Motor Requirements for HVAC Equipment.
 - 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- F. Air Filtration:
 - 1. Air filters and filter frames provided hereunder. Refer to Section 234100 -- Particulate Air Filtration for filter type and configuration.
 - 2. Filter Pressure Gauges: Provide a gauge to indicate pressure differential between entering and leaving side of each filter bank mounted on exterior surface of unit casing near associated filter sections.
 - a. Gauge shall have a nominal 4-inch diameter face.
 - b. Select range of gauge to be approximately twice the dirty filter pressure drop.
 - c. Include static pressure sensors on entering and leaving side of each filter bank.
- G. Electrical Power.
 - 1. General:
 - a. Unit shall be UL or ETL listed.
 - b. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
 - c. Provide all power distribution wiring and control wiring as required for operation

- of equipment components.
 - d. Electrical Enclosures: NEMA 250, Type 1 enclosure contains relays, starters, and terminal strip.
 - e. Wiring devices, raceway, and other components exposed to the outdoors shall be liquid tight and rated for outdoor installation.
 - f. All wiring to lights, switches, and outlets shall be in conduit and internal to the unit.
2. Units with Single Point Motor Power Connections:
 - a. Provide complete electrical power system for single point connection to operate all motor driven equipment and auxiliary functions as specified.
 - b. Enclosure: Mount motor controllers and auxiliary components in a dedicated enclosure for connection to a single power source. Provide enclosure with a main disconnecting means. Provide appropriate cooling to maintain drive temperature within manufacturer's recommendations.
 - 1) Disconnect shall not use linkages that connect internally mounted devices to an operating handle in the panel door.
 - c. Provide one motor starter for each fan motor.
 - d. Provide motor circuit protectors for each motor.
 - e. Provide 24V and/or 120V transformer where required to achieve required functions.
 - f. Provide means of disconnect to isolate each motor and electrical load for maintenance and repair. Remaining equipment shall be capable of operating when any single component is isolated.
 3. Motor Starters, and Motor Controllers. Conform to Section 230514 - Common Motor Control Devices for HVAC.
 4. Disconnect Switches: Disconnect switch or approved means of disconnect in accordance with NFPA 70.

H. Controls.

1. General: Factory furnished control interface for control and monitoring by BAS.
2. Control and Monitoring Functions:
 - a. Unit mounted solid-state, programmable, microprocessor-based electronic controller with digital display to monitor unit operations and adjust control parameters.
 - b. Monitor the following operating conditions:
 - 1) Motor status.
 - 2) Temperature of four entering and leaving heat exchanger air temperature sensors.
 - c. Isolation Damper Control: Open outside air and exhaust air isolation dampers when unit is commanded on and close dampers when unit is commanded off.
 - d. Frost Control: Modulate VFD wheel speed to maintain the exhaust temperature above set point of 34°F, adjustable.
 - e. Economizer Mode: When outdoor air temperature is below the return air temperature, modulate VFD wheel speed to prevent the supply temperature from exceeding the desired supply air temperature set point of 60°F, adjustable.
 - f. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
3. BAS Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor unit.
 - a. Control features and monitoring points displayed locally at unit control panel shall be available through the control system, including, as a minimum, the following:
 - 1) Control:
 - a) Unit On-off operation.
 - b) Isolation damper open-closed position.
 - c) Heat wheel speed command.
 - 2) Monitoring:

- a) On-off motor status.
- b) Outside air entering temperature.
- c) Return air entering temperature.
- d) Exhaust air leaving temperature.
- e) Supply air temperature.
- f) Supply air dirty filter.
- g) Exhaust air dirty filter.

2.5 CAPACITIES AND CHARACTERISTICS

- A. As scheduled on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Packaged Energy Recovery Units.
 - 1. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in 23 05 48 - Vibration and Seismic Controls for HVAC.
 - 2. Install units with clearances for service and maintenance.
 - 3. Pipe drains from drain pans to nearest floor drain, same size as condensate drain connection.

3.3 CONNECTIONS

- A. Install piping adjacent to unit to allow service and maintenance.
- B. Connect piping to units mounted on vibration isolators with flexible connectors.
- C. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

3.4 CONTROLS

- A. Install factory furnish and field mount control devices. Provide control wiring connections to unit mounted controllers.

3.5 CLEANING

- A. After completing system installation and prior to testing, adjusting, and balancing air-to-air heat recovery equipment, and completing startup service, clean unit to remove foreign material and construction dirt and dust.

3.6 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to electrical systems are complete. Verify that proper thermal-overload protection is installed.
 - 3. Verify that moving parts are lubricated with factory-recommended lubricants.
 - 4. Starting procedures for Packaged Energy Recovery Units include the following:
 - a. Energize actuator motor and verify proper operation of motors.
 - b. Measure and record motor electrical values for voltage and amperage.
 - c. Operate bypass dampers from full closed to fully open position.
- C. Tests and Inspections:
 - 1. Operational Test for Packaged Energy Recovery Units:
 - a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - b. Adjust seals and purge.
 - c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - d. Set initial temperature and humidity set points.
 - e. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION

SECTION 238146

WATER SOURCE HEAT PUMP

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water source heat pump.

1.2 DESIGN REQUIREMENTS

- A. Unit shall be capable of operating with entering liquid temperatures between 55°F and 120°F.

1.3 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
 1. Materials List.
 2. Catalog Data.
 3. Product Data.
 4. Performance Data.
 5. Wiring Diagrams.
 6. Shop Drawings.
 7. Installation Instructions.
 8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Water source heat pump			X	X				

1.4 QUALITY ASSURANCE

- A. Unit shall be UL listed.
- B. Unit shall be AHRI/ISO 13256-1 certified and listed by ETL.
- C. Each unit shall be run-tested at the factory with conditioned water to verified unit performance.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids. 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.

PART 2 PRODUCTS

2.1 WATER SOURCE HEAT PUMP

- A. Acceptable Manufacturers: Carrier, Daikin Applied, Trane, Water Furnace.
- B. Factory assembled heat pump unit with reverse cycle for heating and cooling operation, completely assembled, piped and internally wired. Horizontal or vertical configuration as shown on drawings.
- C. Cabinet and Frame Construction: Unit constructed of galvanized steel. Exterior panels insulated with ½" thick, cleanable foil backed, NFPA 90A fire resistant insulation. Factory exterior powder coating painted finish. Seismic mounting brackets. Inlet and outlet duct connections.
 - 1. Drain pans: Plastic or stainless-steel pan. Terminate drain connection on side of unit. Sloped for complete drainage with no standing water. Provide float switch or solid-state electronic condensate overflow protection.
 - 2. Sound control package: Compressor sound attenuation system consisting of compressor sound blanket and sound attenuating multi-density laminated metal plate under the compressor.
- D. Fan Section: Fans shall be direct drive, forward curved, centrifugal, double width, double inlet type; statically and dynamically balanced at factory. L50-100,000 bearing, concentric mounted, Air Handler quality. Fan/motors assembly mounted on a neoprene mount vibration isolators. The fan housing shall be removable from the unit without disconnecting the supply air ductwork for servicing of the fan motor.
 - 1. Motor: ECM type, soft starting, minimum 5 adjustable fan speed settings. Motors shall be permanently lubricated and have thermostatic overload protection. Locate adjacent to access door.
- E. Refrigerant Compressor: High-efficiency single speed rotary or scroll type designed for heat pump duty and mounted on vibration isolators. Two speed compressor for 24,000 btu/hr and higher capacity units. Acoustically deadened galvanized steel mounting bracket to prevent vibration transmission to the cabinet. Single-phase PSC motors with overload protection.
- F. Refrigerant Heat Exchanger: Coaxial tube water-to-refrigerant heat exchanger. 600 PSIG working refrigerant pressure and 450 PSIG working water pressure.
 - 1. Refrigerant heat exchanger, water lines and refrigerant suction lines shall be insulated to prevent condensation at low liquid temperatures below 50°F.
- G. Refrigerant Coil: Coil constructed of seamless copper tubes with mechanically bonded aluminum fins. 600 PSIG working refrigerant pressure. Stainless steel or PVC condensate drain pan sloped to drain outlet and piped to exterior drain piping connection. Secondary condensate overflow float switch, interlock float switch to shutoff supply fan and activate system alarm.
- H. Refrigerant Circuit: Sealed refrigerant circuit including hermetic compressor, bidirectional thermostatic expansion valve, reversing valve, and service ports. R32 or R454B refrigerant.
- I. Filter Section: 2-inch pleated, MERV 8.

- J. Accessories:
1. Coil Kits:
 - a. Minimum Working Pressure: 400 psig.
 - b. Operating Temperatures: From 33 to 211 deg F.
 - c. Hose Length: 24 inches.
 - d. Minimum Hose Diameter: Equal to water-source unitary heat-pump piping connection.
 - e. Hose Material: Braided stainless steel with adapters for pipe connections.
 - f. Isolation Valves: Two-piece, bronze-body ball valves with stainless-steel ball and stem, standard-port threaded connections, and galvanized-steel lever handle. Valves shall be factory installed on supply and return connections of both load-side and source-side heat exchangers. If balancing valve is combination shutoff type with memory stop, the isolation valve may be omitted on the return.
 - g. Strainer: Y-pattern with blowdown valve in supply connections of both load and source side of heat exchangers.
 - h. Balancing Valves: Mount in return connection. Include meter ports to allow flow measurement with differential pressure gage.
 - 1) Manual, venturi-type balancing valve with memory stop.
 2. Refrigerant Detection:
 - a. Provide ASHRAE 15-2022 compliant refrigerant detection with output for BAS alarm input.
- K. Electrical:
1. Single Point Electrical Power Connections: Complete power and control wiring factory assembled and tested.
 2. Control transformer.
 3. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.
 4. Non-fused disconnect, factory installed.
- L. Controls: Microprocessor control system.
1. Heat Pump Control: Microprocessor-based controller that interfaces with a multi-stage electronic thermostat or building automation system to monitor and control unit operation. Provide operational sequencing, fan speed control-, high- and low-pressure switch monitoring, freeze detection, hot water limit thermistor sensing, condensate overflow sensing, lockout mode control, LED status and fault indicators, fault memory, field selectable options and accessory output. The control shall provide fault retry three times before locking out to limit nuisance trips.
 2. BAS Controls: Compressor and fan control by the Building Automation System (BAS). Provide terminal strip for BAS fan, compressor and reversing valve digital input. Refer to 25 10 00 - Building Automation System.
- M. Acoustic Performance.
1. Sound power levels for fan assemblies shall be established in accordance with AMCA 300 and 310.
 2. Sound power levels (db) for assembled unit shall be established by testing or by calculation.
 3. Sound power levels for units and components shall not exceed values as scheduled on Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: Install in accordance with manufacturer's installation instruction. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

3.2 START-UP

- A. Manufacturer's certified representative to provide the following services:
 1. Inspect after installation to ensure equipment is installed in accordance with manufacturer's recommendation.
 2. Supervise initial start-up.
 3. Adjust control system parameters and setpoints to obtain specified performance.
 4. Provide minimum 2 hours of training, including operation and maintenance.

3.3 DEMONSTRATION

- A. Demonstration system operation and adjustment of control system setpoints and parameters to Owner's Authorized Representative.

END OF SECTION

SECTION 238217

ELECTRIC-RESISTANCE AIR COILS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Electric-resistance air coils.

1.2 ACTION SUBMITTALS

- A. Provide submittals for products listed in the Product Table below in accordance with Section 230500 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:
 - 1. Materials List.
 - 2. Catalog Data.
 - 3. Product Data.
 - 4. Performance Data.
 - 5. Wiring Diagrams.
 - 6. Shop Drawings.
 - 7. Installation Instructions.
 - 8. Special Requirement listed herein.
 - 9.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Electric-resistance air coils		x		x				

1.3 QUALITY ASSURANCE

- A. Heaters ETL listed for zero clearance from combustibles, and bear ETL listing mark.
- B. Heaters shall meet the requirements of the NEC and UL 1996, Edition 4.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Coil Assembly: Comply with UL 1995.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."
- E. Equally balance heater electrical load for each step across all electrical phases.

- F. Part-Load Operation: Provide arrangement with operation staged for uninterrupted operation over the full range of airflow down to the minimum airflow indicated.

2.2 ELECTRIC-RESISTANCE AIR COILS

- A. Acceptable manufacturers: Greenheck, Indeeco, Markel, Nailor, and E.H. Price.
- B. Source Limitations: Obtain electric-resistance air coils from single source from single manufacturer.
- C. Heating Elements:
 - 1. Open Elements:
 - a. Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in a frame.
 - b. Safety Screens: Install safety screens to protect operators from accidentally coming into direct contact with elements.
 - 2. Finned Tubular Elements:
 - a. Coiled resistance wire of 80 percent nickel and 20 percent chromium; center-mounted and surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
 - b. Finish finned tubular elements with a baked-on aluminum paint, and mount in a frame.
 - c. Each element individually removable from terminal box.
 - d. Use threaded stainless steel element terminals and hardware.
- D. We need to indicate what our SWE standard is for common HVAC duct mounted applications.
- E. Frame: Galvanized steel; minimum 0.064 inch thick for flanged mounting. Include intermediate element support brackets equally spaced at a maximum of 12 inches o.c. across electric-resistance air coil.
- F. Terminal Box/Control Panel: Unit mounted; with disconnection means and overcurrent protection.
 - 1. Enclosure: NEMA 250, Type 1 or Type 12 enclosure complying with UL 50.
 - 2. Full-face-hinged door.
 - 3. Factory insulate terminal box to prevent condensation from occurring within box.
 - 4. Install a laminated elementary wiring diagram on inside face of heater control panel door or in another protected location than visible to service personnel. Wiring diagram to match installation.
- G. Controls:
 - 1. Safety Controls: Each heater is to be provided with the following factory-mounted safety controls:
 - a. Disk-type thermal cutout switch with automatic reset.
 - b. Primary linear thermal limit cutout switch with automatic reset.
 - c. Secondary linear thermal limit cutout switch with local manual reset.
 - d. Airflow Proving Switch: Pressure differential type; with pressure range selected to ensure reliable operation throughout full range of air-handling unit airflow down to minimum airflow indicated.
 - 2. Capacity Controls:
 - a. Staging Control: Magnetic contactors for switching stages of heat.
 - b. SCR Control: Silicone-controlled rectifier (SCR) for 100 percent stepless capacity control.

3. Remote Monitoring and Control: Include control devices necessary to interface with remote-control signals, including the following:
 - a. Heater on/off control,
 - b. Heater capacity control.
 - c. High-temperature alarm.
 - d. Low-airflow alarm.

- H. Electrical:
 1. Single-Point Field Power Connection: Install and wire the heater to accommodate a single field electrical connection for electrical power.
 2. Disconnecting Means: Provide each heater with a main electrical power connection, door mounted and interlocking, and disconnecting means to prevent access into panel, unless switched to the off position.
 - a. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 42 KW.
 3. Factory install and wire branch circuit fusing or circuit breakers in accordance with NFPA 70.
 4. Pilot Lights: Include labeled pilot lights on face of control panel for the following:
 - a. Power on.
 - b. Low-airflow alarm.
 - c. High-temperature alarm.
 5. Terminations: Wire terminations and field interface terminations to labeled terminal strips.
 6. Control Transformer: Size control circuit transformer for load.
 7. Labeling: Label each electrical device with a laminated phenolic tag.
 8. Use only NRTL-labeled electrical components.

- I. Nameplate: Include the following data:
 1. Manufacturer name, address, telephone number, and website address.
 2. Manufacturer model number.
 3. Serial number.

- J. Capacity and Characteristics: As scheduled on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine ducts and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Install duct heater according to installation instructions, wiring diagram, and labeling supplied with the heater.
- D. Clean coils using materials and methods recommended in writing by manufacturers, and

clean inside of casings and enclosures to remove dust and debris.

3.3 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

END OF SECTION

SECTION 260500

GENERAL ELECTRICAL PROVISIONS

PART 1 GENERAL

1.1 CONTRACT DOCUMENTS

- A. General electrical provisions apply to all work performed in Division 26.
- B. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.
- C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.
- D. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Engineer and Owner's Authorized Representative prior to fabrication.
- E. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.
- F. For products specified by listing one or more manufacturers, followed by "Similar to" and one manufacture's model number, the following requirements apply:
 - 1. Approval of each listed manufacturer is contingent upon that manufacturer having a product which meets the specification, fits in the available space, and is comparable to the listed model.
 - 2. Electrical and space requirements indicated on drawings are based on the listed model and may not be suitable for all manufacturers listed. Provide revisions required to accommodate the model actually furnished.
- G. For products specified by listing one or more manufacturers, followed by a model number for each manufacturer, the following requirements apply:
- H. Provide one of the listed model numbers or an approved substitution.
- I. Electrical and space requirements indicated on the Drawings are based on one of the listed models, and may not be suitable for all models listed. Provide revisions required to accommodate the model actually furnished.

1.2 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): A federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority.
- B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.
- C. Architect/Engineer: The design professional leading the design team and can be either

an architect or engineer.

- D. The words furnish, install, and provide are defined as follows:
 - 1. Furnish: To supply and deliver to the project ready for installation and in operable condition.
 - 2. Install: To place in final position, complete, anchored, connected in operable condition.
 - 3. Provide: To furnish and install complete. Includes the supply of specified services.
 - 4. When neither furnish, install, or provide is stated, provided is implied.
- E. Where content in other sections or divisions is referenced, the words refer and conform are defined as follows:
 - 1. Refer (To): The work referenced in the identified section or division is provided under the referenced section or division. The referenced work is listed for clarity and coordination.
 - 2. Conform (To or With): The work is provided under the section containing the reference and must conform with the requirements of the referenced section or division.

1.3 COORDINATION

- A. Reference drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Architect/Engineer and secure written approval and agreement on necessary adjustments before commencing work.
- B. Architectural drawings govern all other drawings. Reference Architectural drawings for door swings, counter heights and similar items affecting work before rough-in.
- C. Coordinate identification systems with other trades. All electrical systems shall use identical wiring, conduit, and equipment identification and regulatory signage.

1.4 SUBMITTALS AND SHOP DRAWINGS

- A. Conform with requirement of Division 01.
- B. Action Submittal Content.
 - 1. Action submittal information not expressly required by the specifications will not be reviewed.
 - 2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
 - 3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
 - 4. Action submittal requirements are listed in individual specification sections. The following definitions apply.
 - a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
 - b. Catalog data: Manufacturer's standard product cut sheet.
 - c. Product Data: Detailed data including dimensions, weight, materials of

- construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.
- d. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.
 - e. Wiring Diagrams: Power and control wiring diagrams.
 - f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.
 - g. Installation Instructions.
 - h. Special Requirements Listed: Additional requirements indicated in individual specification sections.

1.5 QUALITY ASSURANCE

- A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.
- B. Asbestos products or equipment or materials containing asbestos shall not be used.
- C. Certify that each welder has passed the American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

1.6 DESIGN REQUIREMENTS

- A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.
- B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

1.7 CODES AND STANDARDS

- A. The Work shall conform to the following Codes and Standards:
 - 1. Codes and Regulations of Governing Authority.
 - 2. Americans with Disabilities Act (ADA).
 - 3. Owner's Construction Standards or Guidelines.
- B. Contract Documents are intended to conform with referenced Codes and Standards. Any deviation from applicable codes and standards identified in Contract Documents shall be submitted in writing to the Architect/Engineer.
- C. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.

1.8 SEQUENCING

- A. Submit draft operations and maintenance manuals to Owner's Authorized Representative 30 days prior to substantial completion.
- B. Operator training shall be performed prior to Substantial Completion, or as otherwise approved by the Owner's Authorized Representative.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean and dry place.
- B. Conform with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
- E. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
- F. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
- G. Replace installed products damaged during construction.

1.10 TEMPORARY SERVICES

- A. Provide in accordance with Division 01 as required for completion of work.
- B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.
- C. All electrical systems currently operating including but not limited to lighting control, fire alarm and access control equipment, which serve Owner occupied areas, must be maintained operational during construction. It is the responsibility of the Contractor to provide temporary facilities as required to maintain operation. If any system currently in use must be turned off to perform work, permission must be obtained, and Owner's Authorized Representative notified prior to performing any work.

1.11 FIELD CONDITIONS

- A. Interruption of Existing Service: Do not interrupt electrical, service(s) to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service(s) according to requirements indicated:
 - 1. Notify Architect/Engineer no fewer than ten business days in advance of proposed interruption of service(s).
- B. Do not proceed with interruption of service(s) without written permission of Architect/Engineer.

1.12 OPERATIONS AND MAINTENANCE MANUALS

- A. Furnish operation and maintenance data for project, as described herein.
- B. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF files.
 - 1. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each.
 - 2. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 3. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.
 - 4. Manual Content: Manuals shall contain complete information for each item of mechanical, electrical or other operating equipment. Include as applicable:
 - a. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance.
 - b. Lubrication schedules.
 - c. Performance capacity.
 - d. Final approved product submittals for each product included in project.
 - 1) Mark the model actually provided where the literature covers more than one model. Include all submittal data corrected to "as-built" conditions within the manual.
 - 2) Parts list.
 - e. Maintenance schedules.
 - f. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.
 - 5. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.13 RECORD DRAWINGS

- A. Provide record "as-built" drawings in accordance with Division 1 requirements. Show all deviations from contract drawings and location of underground lines by accurate dimensions from building lines. Show depth of stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Concealed raceways, that contain feeder cables, communication conduits that are 1.5-inch diameter or greater shall be dimensioned from column grids or building lines. Alternately, provide electronically using PDF markup of contract drawings.

1.14 WARRANTY

- A. Warrant all Work included in the Specification for a period of one year from the date of substantial completion, under provisions of Division 1.
- B. During warranty period, remedy without delay or expense to Owner any defects providing, in judgement of Engineer, that such defects are not a result of misuse or abuse on part of Owner.

- C. Warrant that all equipment and installations are in compliance with OSHA regulations.

PART 2 PRODUCTS

2.1 PRODUCTS AND MATERIALS

- A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.
- B. Materials and equipment used as the basis of design is scheduled on Drawings or designated in product specifications. If Contractor chooses to use equipment that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated mechanical and electrical systems needed to provide equal system performance and maintainability.

2.2 ELECTRICAL EQUIPMENT

- A. Electrical Disconnect Switch: Electrical disconnect switches specified for mechanical equipment shall conform to OSHA Lock-out/Tag-out requirements.
- B. All electrical equipment shall be listed as approved for its application by the Underwriters Laboratory or other testing agency approved by the State of Oregon Electrical and Elevator Board. Approval indicates agency meets testing standard requirements for electrical safety required by Oregon Revised Statutes 479.510 through 479.855 and Oregon Administrative Rules.
- C. Enclosure: Provide the following electrical equipment enclosure types unless specifically stated otherwise in individual specification sections.
 1. NEMA 1: Dry, enclosed locations where the ambient temperature will not be outside of the equipment temperature ratings.
 2. NEMA 12: Enclosed mechanical spaces equipped with floor drains where dripping or splashing may occur and where the ambient temperature will not be outside of the VFD temperature ratings.
 3. NEMA 3R: Outdoors spaces exposed to weather, and where NEMA 4 or 4X is not required.
 4. NEMA 4: Mechanical spaces where hose-directed water is expected.
 5. NEMA 4X: Swimming pool mechanical rooms.
 6. Outdoor Enclosures with Temperature Control: NEMA 3R. Provided with a ventilation fan and heater capable of maintaining enclosure temperature within the manufacturer's recommended range. Drive and enclosure shall be a single, UL-listed assembly with single point electrical connections.

2.3 EQUIPMENT CONNECTIONS

- A. Provide a complete electrical connection for all items of equipment including incidental wiring, materials, devices and labor necessary for a complete operating system. The location and method for connection to each item of equipment shall be verified prior to rough-in. The voltage and phase of each item of equipment shall be checked prior to connecting. Motor rotations shall be made in the proper direction. Pump motors are not to be test run until liquid is in the system and proper lubrication to all bearings in unit is checked.
- B. Conduit, wire and circuit breaker sizes for mechanical and similar equipment are based on the equipment ratings of one manufacturer. The equipment actually furnished may have different electrical characteristics. Conduit, wire, and circuit breakers shall not be ordered or installed until exact electrical requirements are obtained. The Contractor is responsible for this coordination.

PART 3 EXECUTION

3.1 ACCESS TO EQUIPMENT AND ACCESSORIES

- A. Install equipment with sufficient access for service. Where not conveniently accessible by other means, provide adequately sized access doors for junction & pull boxes, relays & power packs, and all other electrical equipment requiring access for removal or maintenance. Type, size and exact location of access doors shall be coordinated with Architect/Engineer prior to work.
- B. Provide clearances for maintenance access as indicated on Drawings or as recommended by manufacturer. If access requirements shown on Drawings conflict with manufacturer's recommendations, provide larger clearance of the two.
- C. If equipment location shown on Drawings does not allow required access, notify Architect/Engineer prior to start of work.
- D. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to Architect/Engineer for resolution prior to starting work.
- E. Provide access doors as required for access to electrical equipment. Doors required for access are not necessarily shown on Drawings. Consult with Architect/Engineer for direction on placement of required doors not shown on Drawings.
 - 1. Conform with manufacturer's instructions for installation of access doors. Provide all necessary support and supplemental framing for assembly where the access doors are required. Set accurately in position, plumb, level, and flush to adjacent finish surfaces; and secure to support.
- F. Where ladder access is required to service elevated components, provide and installation that provides for sufficient access with ladder manufacturer's written instructions for use.
- G. Conform with OSHA regulatio.

3.2 ARRANGEMENT AND INSTALLATION OF ELECTRICAL EQUIPMENT AND CONDUIT

- A. Coordinate location of conduit, sleeves, inserts, hangers, cable trays and equipment. Locate conduit, sleeves, inserts, hangers, cable tray and equipment clear of windows,

doors, openings, lights, ducts, piping, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

- B. Equipment and Conduit Support: Coordinate structural systems necessary for conduit and equipment support with pipe and equipment locations to permit proper installation.
- C. Location of conduit sleeves, trenches and chases shall be accurately coordinated with equipment and conduit locations.
- D. Minor Conduit: Small diameter conduit runs from receptacles, lighting, equipment, and similar minor services are generally not shown but must be provided. Contractor is responsible to provide all such minor conduit where needed to maintain electrical spaces clean and neat and to allow full equipment function and maintenance.
- E. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Owner's Authorized Representative. Locate openings that will least affect structural slabs, columns, ribs or beams. Refer to the Architect/Engineer for determination of proper design for openings through structural sections and obtain layout approval prior to cutting or drilling into structure. After Architect/Engineer approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.
- F. Inaccessible Equipment.
 - 1. Where the Owner's Authorized Representative determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
 - 2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.3 EXISTING EQUIPMENT REUSED OR RELOCATED

- A. All equipment designated as existing or furnished by Owner shall be cleaned and repaired before reinstallation. Any items requiring repair shall be brought to the attention of the construction manager before the item is reinstalled. Damage not brought to the attention of the construction manager shall be deemed the result of reinstallation of the item and shall be repaired without expense to the Owner.

3.4 ELECTRICAL SYSTEMS FIRESTOPPING

- A. Do not cover firestop installations until they are examined by the Authority Having Jurisdiction, if required.
- B. Install firestopping in accordance with manufacturer's recommendations and conditions of product UL listing.

3.5 CLEANING SYSTEMS

- A. General: After all equipment, conduits and cable tray are installed, system shall be thoroughly cleaned. Remove all nonessential stickers and labels from equipment or fixtures. Clean all light fixture lenses. Clean interior of conduit systems prior to installation of wiring.
- B. Repair or replace any discolorations or damage to systems, building finish, or furnishings resulting from Contractor's failure to properly clean system.

3.6 START UP

- A. The Electrical Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.
- B. Start equipment in accordance with manufacturer's recommendations and under manufacturer's supervision where required. Ensure that associated breakers, relays, electrical overloads, and other devices intended to protect the equipment are installed and functional prior to startup.

3.7 EXTRA STOCK

- A. Provide extra stock, as described in individual sections, to Owner in accordance with Division 1.

3.8 DEMONSTRATION

- A. General: After installation is complete, demonstrate to Engineer and Owner's Authorized Representative satisfaction as being complete and operational and entirely in conformance with Contract Documents.
- B. Preparation: Prior to demonstration, submit check-off list indicating completeness of submittals and certificates of compliance for review to Owner's Authorized Representative. Operate completed system for one week. Verify that control verification is complete and verification report has been approved by Architect/Engineer.
- C. Arrange for demonstration with Owner, Engineer, required factory technicians, and installer at least one week in advance of demonstration.

END OF SECTION

SECTION 260501
ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SCOPE

- A. It is the intent of these documents to provide the necessary information and adjustments to the electrical system required to meet Code and accommodate installation of the new work.
- B. Contractor shall coordinate with the Owner so that work can be scheduled not to interrupt operations, normal activities, building access, access to different areas. The Owner will cooperate to the best of their ability to assist in a coordinated schedule but will remain the final authority as to time of work permitted.

1.2 EXISTING SYSTEMS

- A. The locations of existing utilities and equipment are shown in an approximate way only and have not been independently verified by the Owner or their authorized representative. The indicated information is derived from record drawings and other data obtained from or with the permission of the owner. The Contractor shall determine the exact location of all existing utilities before commencing work and agrees to be fully responsible for any and all damages which might be occasioned by the Contractor's failure to exactly locate and preserve any and all utilities and equipment. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on the Drawings.
- B. The contractor shall inspect the existing installation prior to bidding and shall judge the work required. Inspection shall include areas within and adjacent to the work of any discipline or trade performing work.
- C. The complete extent of the existing system could not be verified during creation of the construction documents. Unless the contractor's inspection of the existing system determines a greater amount, the contractor shall assume there are 20% more existing electrical systems than what is indicated on the contract drawings.

PART 2 PRODUCTS

2.1 MATERIALS

- A. All materials accumulated during the demolition process are the Owner's property and shall be removed from the job site as directed by the Owner. In coordination with the Architect, these materials shall be made available for their inspection and decision as to whether the Owner will retain possession. Items selected for retention shall be turned over to the Owner. These items shall be delivered to a location on the premises selected by the Owner. All material not selected for retention by the Owner and debris shall be legally disposed of by the Contractor.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

- A. Examine the structure, building, and conditions under which electrical work is to be installed for conditions detrimental to proper and timely completion of electrical work. Do not proceed with work until deficiencies or detrimental conditions have been corrected. Report deficiencies or detrimental conditions of existing electrical work which might be unsuitable to connect with or receive other work. Failure to report shall constitute acceptance of other work as being fit and proper for the reception of electrical work.
- B. Field trace all existing circuitry affected by the project to determine:
 - 1. Source of supply or information collection point within the project area.
 - 2. Load or termination within the project area.
 - 3. Load or termination outside the project area, but supplied from or connected to equipment within the project area.
 - 4. Loads supplied from and located outside of the project area, but have circuitry within the project area.

3.2 DEMOLITION

- A. All removal work required under this contract is not shown on the electrical drawings. Refer to work of other divisions for contract work that may affect existing electrical systems. Coordinate work between trades.
- B. Contractor shall remove all floor, wall or ceiling mounted devices in the "Removal" or "Demolition Area" indicated on the drawing, even if the equipment /or device is not individually shown on the project contract drawings. Unused flush mounted devices, outlet and other boxes in finished areas shall be removed from wall and the remaining hole patched to match adjacent wall surfaces. Unused raceways and wire shall be removed back to source.
- C. Disconnect all existing mechanical equipment scheduled for removal, relocation or abandonment. See mechanical drawings for scope of work. Remove abandoned cables and unusable raceways back to source. Relabel panels and motor control centers to reflect changes.

3.3 EXISTING SYSTEMS MAINTAINED

- A. Maintain existing systems not identified for demolition. Maintaining existing systems includes relocating the systems to coordinate with work of this contract, when work of this contract cannot be done while the existing system is in its present location.
- B. Maintain electrical continuity of all existing systems not identified for demolition. Remove or relocate electrical boxes, conduit, wiring, equipment, fixtures, etc. as may be encountered in removed or remodeled areas in the existing construction affected by this work. Wiring which serves usable existing outlets shall be removed and restored clear of the construction or demolition. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, new conduit and wire shall be provided to bypass the abandoned outlets. If existing conduits pass through partitions or ceiling which are being removed or remodeled, new conduit and wire shall be provided to reroute clear of the construction or demolition and maintain service to the existing load.
- C. Extend circuiting and devices in all existing walls to be furred out.

- D. Re-route existing circuits that are affected as a result of this contract that serve devices to remain in service.
 - 1. Power Circuits (Including removal or relocation of existing panelboards).
 - a. Prior to demolition work trace out and identify each branch circuit and feeder circuit that serves loads in occupied areas.
 - b. Provide temporary wiring, schedule outage and reconnect loads to temporary wiring.
 - c. Provide new wiring in new location.
 - d. Schedule outage, disconnect temporary wiring, and connect loads to new wiring. Remove temporary wiring.
 - e. Outage for each circuit shall not be more than 20 minutes.
 - 2. Signal and Communication Systems.
 - a. Prior to demolition trace out and identify device and systems being served.
 - b. Provide temporary wiring to maintain operation of system throughout facility.
 - c. Schedule outage and connect to temporary wiring and test system.
 - d. Provide new wiring on new location.
 - e. Schedule outage, disconnect temporary wiring, and reconnect to new wiring. Remove temporary wiring.
 - f. Outage for each system shall not be more than 20 minutes.
- E. Keep outages to occupied areas to a minimum and prearrange all outages with the Owner's representative. Requests for outages shall state the specific dates and hours and the maximum durations, with the outages kept to these specific dates and hours and the maximum durations. The Contractor will be liable for any damages resulting from unscheduled outages or for those not confined to the preapproved times. Outages shall take place at times when the facility is not in operation or occupied by non-essential personnel. Include all costs for overtime labor as necessary to maintain electrical services in the initial bid proposal. Temporary wiring and facilities, if used, shall be removed and the site left clean before final acceptance. Requests for outages must be submitted at least (5) days prior to intended shutdown time.
- F. No circuit breaker or disconnects shall be turned off without prior approval from Owner. Coordinate with the Owner's representative responsible for the area or equipment affected for any electrical interruptions which affect the operation of the remaining portions of the facility.
- G. Verify with the General Contractor a location for storage of materials, supplies, tools, rubbish, etc. prior to start of work.

END OF SECTION

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Copper building wire rated 600 V or less.
 2. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. American Bare Conductor.
 2. Cerro Wire LLC.
 3. General Cable Technologies Corporation.
 4. Okonite Company (The).
 5. Southwire Company.

- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
 - 1. Type THHN and Type THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.
- F. Ninety-eight percent conductivity, minimum.
- G. Branch Circuit Wiring: Conductors smaller than No. 12 AWG for power system branch circuits not permitted.
- H. Motor control wires shall be No. 14 minimum.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. 3M Electrical Products.
 - 2. AFC Cable Systems.
 - 3. Gardner Bender.
 - 4. Ideal Industries, Inc.
 - 5. Burndy.
 - 6. Thomas & Betts Corporation.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: Two hole with standard barrels.
 - 3. Termination: Compression.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Stranded conductors only.
- B. Branch Circuits: Copper. Stranded conductors only.

- C. Branch Circuits: Copper. Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- E. VFD Output Circuits Cable: Shall utilize stranded, type XHHW-2 conductors.
- F. Power-Limited Fire Alarm and Control: Solid for No. 14 AWG and smaller.
- G. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- D. VFD Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Use no wire smaller than No. 12 AWG for power and lighting circuits and no smaller than No. 16 AWG for control wiring.
- C. Use No 10 AWG conductors for 20 amperes, 120-volt branch circuit home runs longer than 100 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet. Neutral conductor shall be sized the same as corresponding phase conductors.
- D. Provide dedicated neutral conductor with each branch circuit, do not use a shared neutral conductor between phases unless specifically requested or directed.
- E. For remodel work or where shared neutrals are used by equipment such as system furniture, provide a breaker handle tie as required for the phases sharing the neutral conductor.
- F. Conductor length for parallel feeders shall be identical.
- G. Complete raceway installation between conductor and cable termination points according to Section 260533 - Raceways and Boxes for Electrical Systems prior to pulling conductors and cables.
- H. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

- I. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- J. Couplings and conduit connectors shall have pre-insulated bushings in place prior to pulling wires.
- K. Splice only in accessible junction or outlet boxes. Splice in feeders and services are not permitted. Splice or taps in branch circuits permitted only in junction boxes where circuits divide.
- L. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- M. Support cables according to Section 260529 - Hangers and Supports for Electrical Systems.
- N. Lace or clip groups of feeder conductors at distribution centers, pullboxes, and wireways.
- O. Provide copper grounding conductors and straps. A ground wire shall be pulled through conduits and used as the equipment grounding conductor.
- P. Wire and cable shall be brought to the job site in the original containers bearing the U.L. label.
- Q. Installing wires of different voltage systems in the same raceway, box, gutter or other enclosure is prohibited.
- R. Radius of cable bends shall not be less than ten times the outer diameter of the cable.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Follow manufacturer's instructions using manufacturer's recommended tools.
- D. Stripping Insulation: Carefully strip, avoid nicking conductor. No "ringing".
- E. Design: Connectors shall be designed and approved for the purpose used. Connectors between aluminum and copper shall be listed "AL/CU" for the purpose of preventing electrolytic action.
- F. Bare Connectors and Conductor Free Ends: Wrap with insulating rubber or friction tape to equivalent insulation of wire.
- G. Ground Continuity to Metallic Surfaces: Remove any paint coating and polish surface beneath connection.
- H. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

- I. No splices or taps permitted in feeder branch circuiting terminating at a single outlet.
- J. Conductor and cable copper shall not be reduced at the terminal for making connections.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 - Identification for Electrical Systems.
- B. Color-coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied integral pigmentation or field applied for sizes larger than No. 6 AWG if authorities having jurisdiction permit. Where field applied, apply colored plastic tape in spiral half-lap over exposed conductor portions in manholes, boxes, panels, switchboards, and other enclosures.
 - 2. Colors for 208/120-V circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White with corresponding phase color stripe.
 - 3. Colors for 480/277-V circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray with corresponding phase color stripe.
 - 4. Color for Equipment Grounds: Green.
 - 5. Color for Isolated Grounds: Green with yellow stripe.
- C. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Continuity test on each conductor and cable.
 - g. Uniform resistance of parallel conductors.
 - h. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300-volt rated

cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute.

- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Metal conduits and fittings.
 2. Nonmetallic conduits and fittings.
 3. Metal wireways and auxiliary gutters.
 4. Nonmetal wireways and auxiliary gutters.
 5. Surface raceways.
 6. Boxes, enclosures, and cabinets.
 7. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. Calconduit.
 - c. Thomas & Betts Corporation; A Member of the ABB Group.
 - d. Western Tube and Conduit Corporation.
 - e. Wheatland Tube Company.
 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch, minimum.
 4. EMT: Comply with ANSI C80.3 and UL 797.
- B. Metal Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - c. Thomas & Betts Corporation; A Member of the ABB Group.
 - d. Western Tube and Conduit Corporation.
 - e. Wheatland Tube Company.
 2. Comply with NEMA FB 1 and UL 514B.
 3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. Fittings, General: Listed and labeled for type of conduit, location, and use.
 5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 6. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew.
 7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Nonmetallic Conduit:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Anamet Electrical, Inc.
 - b. CANTEX INC.
 - c. Kraloy.
 - d. Thomas & Betts Corporation; A Member of the ABB Group.
 2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. ENT: Comply with NEMA TC 13 and UL 1653.
 4. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
 5. LFNC: Comply with UL 1660.
- B. Nonmetallic Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anamet Electrical, Inc.
 - b. CANTEX INC.
 - c. Kraloy.
 - d. RACO; Hubbell.
 - e. Thomas & Betts Corporation; A Member of the ABB Group.
 2. Fittings, General: Listed and labeled for type of conduit, location, and use.
 3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
 - a. Fittings for LFNC: Comply with UL 514B.
 4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line, an Eaton business.
 2. Hoffman; a brand of nVent.
 3. MonoSystems, Inc.
 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Crouse-Hinds, an Eaton business.
 - 2. FSR Inc.
 - 3. Hoffman; a brand of nVent.
 - 4. Hubbell Incorporated.
 - 5. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 6. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep minimum.
- J. Gangable boxes are allowed.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Fiberglass.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250,.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 5. Damp or Wet Locations: GRC.
 - 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
 - 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with requirements in Section 260529 - Hangers and Supports for Electrical Systems for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- M. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- N. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- P. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- R. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- T. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not

exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Conduit extending from interior to exterior of building.
 4. Conduit extending into pressurized duct and equipment.
 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 6. Where otherwise required by NFPA 70.
- W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07.

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Raceway and Metal-Clad Cable.
 2. Conductor, Communication and Control Cable.
 3. Warning Labels and Signs.
 4. Equipment Identification Nameplates.
 5. Wiring Device Identification.
 6. Miscellaneous Identification Products.
 7. Pull box and junction box identification.

1.3 RELATED SECTIONS

- A. Division 01, General Requirements.
- B. Division 26, Electrical.
- C. Section 260519 - Low Voltage Electrical Power Conductors and Cables.
- D. Section 260533 - Raceways and Boxes for Electrical Systems.
- E. Section 262726 - Wiring Devices.
- F. Section 262913 - Motor Circuit Disconnects.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.

- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 RACEWAY AND METAL-CLAD CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Brady Corporation.
 - 2. Ideal Industries, Inc.
 - 3. Marking Services, Inc.
 - 4. Seton.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible, labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

2.3 EQUIPMENT IDENTIFICATION NAMEPLATES

- A. Engraved, Three-layer, Laminated Acrylic or Melamine Nameplate: Drilled or punched for mechanical fasteners. White letters on black background, except emergency equipment nameplates shall have white letters on red background. Beveled edges with minimum letter height of 1/2-inch unless otherwise noted.

2.4 WIRING DEVICE IDENTIFICATION

- A. Self-adhesive vinyl labels, machine printed with black 1/8 inch high text on clear background, except emergency wiring devices shall have black letters on red background, by thermal transfer or equivalent process.

PART 3 EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Install identifying devices before installing acoustical ceilings and similar concealment.
- B. Verify identity of each item before installing identification products.

- C. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- D. Apply identification devices to surfaces that require finish after completing finish work.
- E. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- F. Self-Adhesive Labels:
 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Junction Box Identification: Identify each junction box with complete system description, including system voltage, panel, and circuits contained within.
 1. Acceptable Identification Methods: Neat hand lettering with permanent black marker, machine printed, adhesive vinyl labels, or engraved nameplates.
 2. Acceptable Locations:
 - a. In concealed locations: Locate identification on outside of junction box cover.
 - b. In exposed locations: Locate identification on inside of junction box cover.
 3. Fire Alarm Junction Boxes: Box covers shall be painted red and labeled "FIRE ALARM" prior to installation.
- C. Wiring Device Plate Identification: Apply machine printed, self-adhesive vinyl labels at bottom center of device plate for single gang and multiple gang devices.
 1. Label shall provide branch circuit identification.
 - a. Example: "B-16" indicating panel "B" and circuit #16.
- D. Equipment Identification Labels:
 1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 2. Install nameplates for equipment, including but not limited to, the following:
 - a. Disconnect switches.
 - b. Battery-inverter units.
 3. Provide the following information on each nameplate:
 - a. Equipment name/tag:
 - 1) Matching the designation indicated on the contract documents, or identifying the load controlled or function of the equipment where no specific tag is shown on the contract documents unless otherwise noted.
 - b. Equipment operating voltage, phase, wiring configuration and ampacity.
 - 1) Example: 480V/3PH/4W/225A.
 - c. Source of power supply, including circuit number:
 - 1) Example: FED FROM 4NL1-3.
- E. At service entrance equipment, provide a nameplate identifying the maximum available fault current and "as of" effective date.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Standard-grade receptacles, 125 V, 20 A.
 2. GFCI receptacles, 125 V, 20 A.
 3. Wall plates.

1.3 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Comply with NEMA WD 1.
- E. Devices that are manufactured for use with modular plug-in connectors are not acceptable.
- F. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- G. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Essential Electrical System: Red.
- H. Wall Plate Color: For plastic covers, match device color.
- I. Receptacles shall be Industry Class 5362.
- J. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 SPECIFICATION-GRADE RECEPTACLES, 125 V, 20 A

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - 2. Leviton Manufacturing Co., Inc.
 - 3. Pass & Seymour/Legrand (Pass & Seymour).
- B. Duplex Receptacles, 125 V, 20 A:
 - 1. Description: Two pole, three wire, and self-grounding.
 - 2. Configuration: NEMA WD 6, Configuration 5-20R.
 - 3. Standards: Comply with UL 498 and FS W-C-596.
- C. Weather-Resistant Duplex Receptacle, 125 V, 20 A:
 - 1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
 - 2. Configuration: NEMA WD 6, Configuration 5-20R.
 - 3. Standards: Comply with UL 498.
 - 4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

- D. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A:
 - 1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
 - 2. Configuration: NEMA WD 6, Configuration 5-20R.
 - 3. Standards: Comply with UL 498.
 - 4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.3 GFCI RECEPTACLES, 125 V, 20 A

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hubbell Incorporated (Commercial and Industrial Group - Wiring Device-Kellems).
 - 2. Leviton Manufacturing Co., Inc.
 - 3. Pass & Seymour/Legrand (Pass & Seymour).
- B. Duplex GFCI Receptacles, 125 V, 20 A:
 - 1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
 - 2. Configuration: NEMA WD 6, Configuration 5-20R.
 - 3. Type: Feed through.
 - 4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.4 WALL PLATES

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035-inch-thick, satin-finished, Type 302 stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a

- joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:
 - a. Cut back and pigtail or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 7. When conductors larger than No. 12 AWG are installed on 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
 10. Install receptacles at 18 inches (to center line of faceplate) above finished floor, unless otherwise noted.
 11. Verify mounting height and orientation of wiring devices above counter tops and benches with Architectural Details prior to rough-in.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.
 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- F. Device Plates:
1. Do not use oversized or extra-deep plates.
 2. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush, level, or do not cover rough wall opening.
 3. Where outlets are adjacent to each other at same mounting heights, install under common device plate, except where outlets are of different voltages, such as data and duplex receptacle, unless otherwise noted.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches

under single, multigang wall plates.

- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Tests for Receptacles:
 1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- D. Wiring device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Fusible switches.
 2. Non-fusible switches.
 3. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 1. Enclosure types and details for types other than NEMA 250, Type 1.
 2. Current and voltage ratings.
 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 1. Include plans, elevations, sections, details, and attachments to other work.
 2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in electronic format.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and

adjacent surfaces and other items. Comply with indicated maximum dimensions.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.3 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. Siemens Industry, Inc., Energy Management Division.
 - 3. Square D; Schneider Electric USA.
- B. Type HD, Heavy Duty, Six Pole, Single Throw, 240-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 - 4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
 - 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 6. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 7. Service-Rated Switches: Labeled for use as service equipment.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 260548 "Seismic

Controls for Electrical Systems."

- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify correct phase barrier installation.
 - i. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
 - 2. Electrical Tests:
 - a. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETAATS. Investigate values of insulation resistance less than those published in Table 100.1 or as

recommended in manufacturer's published data.

- c. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

- 1. Test procedures used.
- 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
- 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION