Ogden High Boiler/ ROTC HVAC Replacement Project
Ogden School District
1950 Monroe Blvd
Ogden UT, 84401

RFP 23-002

Project Date: May 30th – September 1st 2023
Bid Due: September 1st, 2022 1:00PM

Project:

Ogden High School
2828 Harrison Blvd
Ogden UT, 84403
NOTICE TO BIDDERS

Electronic bids will be received by the Board of Education of the Ogden School District, for the Ogden High Boiler/ ROTC HVAC Replacement Project. Bids will be in accordance with these specifications. This project is federally funded, and Prevailing Wages (Davis Bacon) shall apply.

A Pre-bid walk through will be held Tuesday August 23rd at 2828 Harrison Blvd, Ogden Utah at 11:00am. Attendance at the bid walk is mandatory to qualify contractors to bid this project.

The Office of the Director of Support Services will receive electronic bids until the hour of 1:00pm September 1st 2022. Bids must be submitted on Sciquest.com.

A bid bond of the amount of (5%) of the bid, made payable to the Board of Education of the Ogden School District, shall accompany bid. If a certified check is used in lieu of the bid bond, a certificate from an approved surety company guaranteeing execution of 100% Performance Bond and 100% Payment Bond must accompany bid.

The Ogden School District Board of Education reserves the right to accept or reject any or all bids or to waive any informality or technicality in any bid in the interest if the District.

If bidders have questions or need to seek clarification during this bidding process, then questions must be received in writing through Sciquest.com by no later than August 30th at 10:00am.

BOARD OF EDUCATION OF THE OGDEN SCHOOL DISTRICT
KEN CRAWFORD, DIRECTOR OF SUPPORT SERVICES
BID FORM RFP 23-002

Name of Bidder________________________________________ Date________________

Address of Bidder__________________________________________________________________________

To the Board of Education of the Ogden City School District

1950 Monroe Blvd

Ogden, UT 84401

RFP22-014 Project Dates: May 30th – September 1st 2023

The undersigned, in compliance with your invitation for bids for the Ogden High Boiler/ROTC HVAC Replacement Project having examined the drawings, specifications and related documents, and the site of the proposed work and being familiar with all of the conditions surrounding the construction of the proposed project, including the availability of labor, do hereby propose to furnish all labor, materials and supplies as required for the work in accordance with the Contract Documents as specified and within the time set forth and at the price stated below.

I/We acknowledge receipt of the following addenda if applicable

#1_________________ Date________________

#2_________________ Date________________

Base Bid Project: This base bid shall include all work in the construction documents for RFP 23-002 Ogden High Boiler/ROTC HVAC Replacement Project. I/We agree to perform this work for the sum of:

__________________________________________ Dollars ($__________________)

(In case of discrepancy, written amount shall govern)

Bid Alternate Project: This alternate bid shall include all work in the Bid Alternate portion in the construction documents for RFP 23-002 Ogden High/ROTC HVAC Replacement Project.

__________________________________________ Dollars ($__________________)

(In case of discrepancy, written amount shall govern)
I/We guarantee to complete the work as defined in the Drawings and specifications.

Enclosed is _____________ for bid security as required in the sum $__________________

The undersigned Contractors license number for Utah is____________________ and my bid limit is $__________________

Upon receipt of Notice of Acceptance of this bid, the undersigned agrees to execute the Contract and within five (5) days deliver Owners Protective Bonds in the prescribed form in the amount of 100% of the General Construction Contract Price for faithful performance of the contract. The Certified Check, Cashier’s Check or Bid Bond attached, in the amount not less than five percent (5%) of the Body shall become the property of the Board of Education of the Ogden City School District in the event that the Contract is not negotiated and/or the Owner’s Protective Bonds delivered within the time set forth, as liquidated damages for the delay and additional expense caused thereby.

Respectfully Submitted,

Name of Bidder ____________________________________________________________

Authorized Signature ______________________________________________________

Phone Number ____________________________________________________________

Email Address ____________________________________________________________
STANDARD CONTRACT TERMS AND CONDITIONS

1. AUTHORITY: Provisions of this contract are pursuant to the authority set forth in Utah Code §§ 63G - 6a Utah Procurement Code; as amended, Utah Administrative Code R33. Administrative Services, Purchasing and General Services; and/or Ogden School District’s Purchasing and Procurement Policy; and related statutes which govern DISTRICT’S purchase of goods and services.

2. CONTRACT JURISDICTION, CHOICE OF LAW, & VENUE: Provisions of this contract shall be governed by the laws of the State of Utah. The parties will submit to the jurisdiction of the courts of the State of Utah for any dispute arising out of this contract or breach thereof. Venue shall be in Ogden City, in the Judicial Court for Weber County.

3. LAWS AND REGULATIONS: CONTRACTOR and any and all supplies, services and equipment furnished under this contract will comply fully with all applicable Federal and State laws and regulations, including licensure and certification requirements.

4. RECORDS ADMINISTRATION: CONTRACTOR shall maintain, or supervise the maintenance of all records necessary to properly account for payments made to CONTRACTOR for costs authorized by this contract. These records shall be retained by CONTRACTOR for at least four years after the contract terminates, or until all audits initiated within the four years, have been completed, whichever is later. CONTRACTOR agrees to allow DISTRICT, State, and Federal auditors and DISTRICT staff, access to all records to this contract for audit, inspection, and monitoring of services. Such access will be during normal business hours, or by appointment.

5. CERTIFY REGISTRATION AND USE OF EMPLOYMENT "STATUS VERIFICATION SYSTEM": The Status Verification System, also referred to as “E- Verify”, only applies to contracts issued through a Request for Proposal process, and to sole sources that are included within a Request for Proposal. It does not apply to Invitation for Bids or to the Multiple Stage Bid.

5.1 Status Verification System

1. Each offeror and each person signing on behalf of any offeror certifies as to its own entity, under penalty of perjury, that the named CONTRACTOR has registered and is participating in the Status Verification System to verify the work eligibility status of the CONTRACTOR ’S new employees that are employed in the State of Utah in accordance with applicable immigration laws including UCA § 63G-12-302.

2. CONTRACTOR shall require that the following provision be placed in each subcontract at every tier: “The subcontractor shall certify to the main (prime or general) contractor by affidavit that the subcontractor has verified through the Status Verification System the employment status of each new employee of the respective subcontractor, all in accordance with applicable immigration laws including UCA § 63G -12- 302 and to comply with all applicable employee status verification laws. Such affidavit must be provided prior to the notice to proceed for the subcontractor to perform the work.”
3. DISTRICT will not consider a proposal for award, nor make any award where there
has not been compliance with this section.

4. Manually or electronically signing the Proposal is deemed CONTRACTOR’ S
certification of compliance with all provisions of this employment status verification
certification required by all applicable status verification laws including UCA § 63G-12-
302.

5.2 Indemnity Clause for Status Verification System
1. CONTRACTOR (includes, but is not limited to any Contractor, Design Professional,
   Designer or Consultant) shall protect, indemnify and hold harmless, DISTRICT and its
   officers, employees, agents, representatives and anyone the DISTRICT may be liable to,
   against any claim, damages or liability arising out of or resulting from violations of
   Section 5 of this Contract whether violated by employees, agents, or contractors of the
   following: (a) CONTRACTOR; (b) Subcontractor at any tier; and/or (c) any entity or
   person for whom the CONTRACTOR or Subcontractor may be liable.

2. Notwithstanding Section 5.2.1. above, Design Professionals or Designers under direct
contract with DISTRICT shall only be required to indemnify DISTRICT for a liability
claim that arises out of the Design Professional’s services, unless the liability claim arises
from the Design Professional’s negligent act, wrongful act, error or omission, or other
liability imposed by law except that the Design Professional shall be required to
indemnify the DISTRICT in regard to subcontractors or sub consultants at any tier that
are under the direct or indirect control or responsibility of the Design Professional, and
includes all independent contractors, agents, employees or anyone else for whom the
Design Professional may be liable at any tier.

6. CONFLICT OF INTEREST: CONTRACTOR represents that none of its officers or
   employees are officers or employees of the DISTRICT, unless disclosure has been made in
   accordance with U.C.A. § 67 -16 -8.

7. CONTRACTOR, AN INDEPENDENT CONTRACTOR: CONTRACTOR shall be an
   independent contractor, and as such, shall have no authorization, express or implied, to bind
   DISTRICT to any agreements, settlements, liability or understanding whatsoever, and agrees not
   to perform any acts as agent for DISTRICT, except as herein expressly set forth. Compensation
   stated herein shall be the total amount payable to CONTRACTOR by DISTRICT.
   CONTRACTOR shall be responsible for the payment of all income tax and social security
   amounts due as a result of payments received from DISTRICT for these contract services.
   Persons employed by DISTRICT and acting under the direction of DISTRICT shall not be
deemed to be employees or agents of CONTRACTOR.

8. INDEMNITY CLAUSE: CONTRACTOR agrees to indemnify, save harmless, and release
   DISTRICT, and all its officers, agents, volunteers, and employees from and against any and all
   loss, damages, injury, liability, suits, and proceedings arising out of the performance of this
   contract which are caused in whole or in part by the acts or negligence of CONTRACTOR ’S
   officers, agents, volunteers, or employees, but not for claims arising from DISTRICT ’S sole
negligence. The parties agree that if there are any Limitations of CONTRACTOR’S Liability, including a limitation of liability for anyone for whom CONTRACTOR is responsible, such Limitations of Liability will not apply to injuries to persons, including death, or to damages to property.

9. **EMPLOYMENT PRACTICES CLAUSE:** CONTRACTOR agrees to abide by the provisions of Title VI and VII of the Civil Rights Act of 1964 (42 USC 2000e) which prohibits discrimination against any employee or applicant for employment or any applicant or recipient of services, on the basis of race, religion, color, or national origin; and further agrees to abide by Executive Order No. 11246, as amended, which prohibits discrimination on the basis of sex; 45 CFR 90 which prohibits discrimination on the basis of age; and Section 504 of the Rehabilitation Act of 1973, or the Americans with Disabilities Act of 1990 which prohibits discrimination on the basis of disabilities. Also, CONTRACTOR agrees to abide by Utah’s Executive Order, dated December 13, 2006, which prohibits sexual harassment in the work place.

10. **SEPARABILITY CLAUSE:** A declaration by any court, or any other binding legal source, that any provision of this contract is illegal and void shall not affect the legality and enforceability of any other provision of this contract, unless the provisions are mutually dependent.

11. **RENEGOTIATION OR MODIFICATIONS:** This contract may be amended, modified, or supplemented only by written amendment to the contract, executed by authorized parties hereto, and attached to the original signed copy of the contract. Automatic renewals will not apply to this contract.

12. **DEBARMENT:** CONTRACTOR certifies that neither it nor its principals are presently nor have ever been debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction (contract), by any governmental department or agency. If CONTRACTOR cannot certify this statement, attach a written explanation for review by the DISTRICT. CONTRACTOR must notify the District Director of Purchasing within 30 days if debarred by any governmental entity during the contract period.

13. **TERMINATION:** Unless otherwise stated in the Special Terms and Conditions, this contract may be terminated, for cause by either party, in advance of the specified termination date, upon written notice being given the other party. The party in violation will be given ten (10) working days after notification to correct and cease the violations, after which the contract may be terminated for cause. This contract may be terminated without cause, in advance of the specified expiration date, by either party, upon sixty (60) days prior written notice being given the other party. On termination of this contract, all accounts and payments will be processed according to the financial arrangements set forth herein for approved services rendered to date of termination.

14. **NON-APPROPRIATION OF FUNDS:** CONTRACTOR acknowledges that DISTRICT cannot contract for the payment of funds not yet appropriated by the Utah State Legislature, Utah State Board of Education or District Board of Education (BOARD). If the DISTRICT becomes subjected to a legislative change, revocation of statutory authority, lack of appropriated funds or
availability of funds which would render CONTRACTOR’s delivery or performance under the contract impossible, or unnecessary, this contract will be terminated, either in whole or in part. If funding to DISTRICT is reduced due to an order by the Legislature or Governor, or is required by State law, or if federal funding (when applicable) is not provided, or requires any return or “give-back” of funds required for DISTRICT to continue payments, or if the BOARD mandates any cuts or holdbacks in spending, DISTRICT may terminate this contract or proportionately reduce the services and purchases of obligations and the amount due from DISTRICT upon 30 days written notice. Where funding is controlled entirely by DISTRICT, before discontinuing funding, DISTRICT, at its discretion, will make efforts to; a) identify other goods/services that perform substantially the same functions; b) identify if any funding is available through a reallocation or reprogramming of other appropriated or non-appropriated funds, and c) make its best efforts to request and secure such funds from the appropriate entities (collectively, a “Non-Appropriation”). If a Non-Appropriation occurs, DISTRICT shall remit all amounts due to CONTRACTOR through the date of termination. DISTRICT shall not be in default under this contract for nonpayment and will not be liable for any future commitments, penalties, or liquidated damages.

15. SALES TAX EXEMPTION: DISTRICT’s sales and use tax exemption number is 12057251 -002 -STC. The tangible personal property or services being purchased are being paid from DISTRICT funds and used in the exercise of that entity’s essential functions. If the items being purchased are construction materials, they will be converted into real property by employees of DISTRICT, unless otherwise stated in the contract.

16. WARRANTY (This paragraph is NOT applicable to architect, engineering, and construction service providers): CONTRACTOR agrees to warrant and assume responsibility for all products (including hardware, firmware, and/or software products) that it licenses, contracts, or sells to DISTRICT under this contract for a period of one (1) year, unless otherwise specified and mutually agreed upon elsewhere in this contract. CONTRACTOR acknowledges that all warranties granted to the buyer by the Uniform Commercial Code of the State of Utah apply to this contract. Product liability disclaimers and/or warranty disclaimers from the seller are not applicable to this contract unless otherwise specified and mutually agreed upon elsewhere in this contract. In general, CONTRACTOR warrants that: 1) the product will do what the salesperson said it would do, 2) the product will live up to all specific claims that the manufacturer makes in their advertisements, 3) the product will be suitable for the ordinary purposes for which such product is used, 4) the product will be suitable for any special purposes that DISTRICT has relied on CONTRACTOR’S skill or judgment to consider when it advised DISTRICT about the product, 5) the product has been properly designed and manufactured, and 6) the product is free of significant defects or unusual problems about which DISTRICT has not been warned. Remedies available to DISTRICT include the following: CONTRACTOR will repair or replace (at no charge to DISTRICT) the product whose nonconformance is discovered and made known to CONTRACTOR in writing. If the repair and/or replaced product prove to be inadequate, or fails of its essential purpose, CONTRACTOR will refund the full amount of any payments that have been made. Nothing in this warranty will be construed to limit any rights or remedies DISTRICT may otherwise have under this contract.
17. **INSURANCE**: CONTRACTOR must carry insurance with policy limits no less than $1,000,000 per incident and $3,000,000 in aggregate. CONTRACTOR must provide proof of insurance to DISTRICT and must add DISTRICT as an additional insured with notice of cancellation.

18. **PUBLIC INFORMATION**: CONTRACTOR agrees that the contract and related Sales Orders and Invoices will be public documents, and may be available for distribution. CONTRACTOR gives DISTRICT express permission to make copies of the contract, related Sales Orders and Invoices in accordance with the State of Utah Government Records Access and Management Act (GRAMA). Except as for sections identified in writing and expressly approved by DISTRICT’s Purchasing department, CONTRACTOR also agrees that CONTRACTOR’s response to the solicitation will be a public document, and copies may be given to the public under GRAMA laws. Permission to make copies as noted will take precedence over any statements of confidentiality, proprietary information, copyright information, or similar notation.

19. **DELIVERY**: Unless otherwise specified in this contract, all deliveries will be F.O.B. destination with all transportation and handling charges paid by CONTRACTOR. Responsibility and liability for loss or damage will remain with CONTRACTOR until final inspection and acceptance when responsibility will pass to DISTRICT except as to latent defects, fraud and CONTRACTOR’s warranty obligations.

20. **ORDERING AND INVOICING**: All orders will be shipped promptly in accordance with the delivery schedule. CONTRACTOR will promptly submit invoices (within 30 days of shipment or delivery of services) to DISTRICT. DISTRICT contract number and/or release number shall be listed on all invoices, freight tickets, and correspondence relating to the contract order. Prices paid by DISTRICT will be those prices listed in the contract. DISTRICT has the right to adjust or return any invoice reflecting incorrect pricing or upon which DISTRICT contract number and/or release number is not listed.

21. **PROMPT PAYMENT DISCOUNT**: Offeror may quote a prompt payment discount based upon early payment; however, discounts offered for less than 30 days will not be considered in making the award. CONTRACTOR shall list payment discount terms on invoices. The prompt payment discount will apply to payments made with DISTRICT Purchasing or Travel Card (major credit card); and checks. The date from which discount time is calculated will be the date a correct invoice is received or receipt of shipment, whichever is later; except that if testing is performed, the date will be the date of acceptance of the merchandise.

22. **PAYMENT**: Payments are normally made within 30 days following the date the order is delivered or the date a correct invoice is received, whichever is later. After 60 days from the date a corrected invoice is received by the appropriate DISTRICT official, CONTRACTOR may assess interest on overdue, undisputed account charges up to a maximum of the interest rate paid by the IRS on taxpayer refund claims, plus 2%, computed similarly as the requirements of U.C.A. § 15-6-3. The IRS rate is adjusted quarterly, and is applied on a per annual basis, on the invoice amount that is overdue. All payments to CONTRACTOR will be remitted by mail, electronic funds transfer, or DISTRICT Purchasing Card (major credit card).
23. **PATENTS, COPYRIGHTS, ETC.:** CONTRACTOR will release, indemnify and hold DISTRICT, its officers, agents and employees harmless from liability of any kind or nature, including CONTRACTOR’s use of any copyrighted or un-copyrighted composition, secret process, patented or un-patented invention or appliance furnished or used in the performance of this contract.

24. **ASSIGNMENT/SUBCONTRACT:** Contractor will not assign, sell, transfer, subcontract or sublet rights, or delegate responsibilities under this contract, in whole or in part, without the prior written approval of DISTRICT.

25. **DEFAULT AND REMEDIES:** Any of the following events will constitute cause for DISTRICT to declare CONTRACTOR in default of this contract: 1) nonperformance of contractual requirements; 2) material breach of any term or condition of this contract. DISTRICT will issue a written notice of default providing a ten (10) day period in which CONTRACTOR will have an opportunity to cure. Time allowed for cure will not diminish or eliminate CONTRACTOR’s liability for damages. If the default remains, after CONTRACTOR has been provided the opportunity to cure, DISTRICT may do one or more of the following: 1) exercise any remedy provided by law; 2) terminate this contract and any related contracts or portions thereof; 3) impose liquidated damages, if liquidated damages are listed in the contract; 4) suspend CONTRACTOR from receiving future solicitations.

26. **FORCE MAJEURE:** Neither party to this contract will be held responsible for delay or default caused by fire, riot, acts of God and/or war which is beyond that party’s reasonable control. DISTRICT may terminate this contract after determining such delay or default will reasonably prevent successful performance of the contract.

27. **PROCUREMENT ETHICS:** CONTRACTOR understands that a person who is interested in any way in the sale of any supplies, services, construction, or insurance to the DISTRICT is violating the law if the person gives or offers to give any compensation, gratuity, contribution, loan or reward, or any promise thereof to any person acting as a procurement officer on behalf of the DISTRICT, or who in any official capacity participates in the procurement of such supplies, services, construction, or insurance, whether it is given for their own use or for the use or benefit of any other person or organization. (U.C.A. § 63G-6a-2304.5).

28. **CONFLICT OF TERMS:** CONTRACTOR Terms and Conditions that apply must be in writing and attached to the contract. No other Terms and Conditions will apply to this contract including terms listed or referenced on CONTRACTOR’S website, terms listed in a CONTRACTOR quotation/sales order, etc. In the event of any conflict in the contract Terms and Conditions, the order of precedence shall be: 1) Attachment A: District Standard Contract Terms and Conditions; 2) District Contract Signature page(s), 3) District Special Terms and Conditions; 4) Contractor Terms and Conditions.

29. **ENTIRE AGREEMENT:** This agreement, including all Attachments and documents incorporated hereunder, and the related DISTRICT solicitation constitutes the entire agreement between the parties with respect to the subject matter, and supersedes any and all other prior and contemporaneous agreements and understandings between the parties, whether oral or written.
The terms of this Agreement shall supersede any additional or conflicting terms or provisions that may be set forth or printed on CONTRACTOR ’S work plans, cost estimate forms, receiving tickets, or any other related standard forms or documents that may subsequently be used to implement, record, or invoice services hereunder from time to time, even if such standard forms or documents have been signed or initialed by a representative of DISTRICT. The parties agree that the terms of this Agreement shall prevail in any dispute between the terms of this Agreement and the terms printed on any such standard forms or documents, and such standard forms or documents shall not be considered written amendments of this Agreement.
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SECTION 01 1000 - SUMMARY

PART 1 - PRODUCTS

1.1 SUMMARY

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. Project information.
   2. Work covered by Contract Documents.
   3. Owner-furnished products.
   4. Access to site.
   5. Coordination with occupants.
   6. Work restrictions.
   7. Specification and drawing conventions.
   8. Miscellaneous provisions.

B. Related Requirements:
   1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

C. AIA Documentation is to be utilized for this project.
   1. AIA Document A201 - General Conditions of the Contract for Construction is incorporated by reference. Copies may be obtained from the Engineer for the cost of reproduction.

1.3 PROJECT INFORMATION

A. Project Identification: Ogden High School Boiler and ROTC HVAC Replacement.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:
   1. Fan Replacement and Controls Upgrade

1.5 ACCESS TO SITE

A. General: 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. 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 [loading areas] 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 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. 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 COORDINATION WITH OCCUPANTS

A. Full Owner Occupancy: Owner will occupy site and 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.

1.7 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.
   1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

B. On-Site Work Hours: The contractor will need to schedule work to be performed. Generally, the building is occupied from 7:00 A.M. to 5:00 P.M Monday through Friday. The building is occupied to a lesser extent during the summer when school is not in session. It is anticipated that this project will require after hours work which will need to be coordinated and arranged with the owner.

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 providing temporary utility services according to requirements indicated:
   1. Notify [Owner] not less than [two] days in advance of proposed utility interruptions.
   2. Obtain [Owner's] permission before proceeding with utility interruptions.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
   1. Notify [Owner] not less than [two] days in advance of proposed disruptive operations.
   2. Obtain, [Owner's] written permission before proceeding with disruptive operations.
1.8 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. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. 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.
      a. Abbreviations: Materials and products are identified by abbreviations
      b. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 1000
SECTION 01 2300 - ALTERNATES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS
   A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
   2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES
   A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
      1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
   B. Execute accepted alternates under the same conditions as other work of the Contract.
   C. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1. Refrigerant Pipe Covering.
   2. Alternate: **Rigid** refrigerant line set pipe cover. Cover Guard (Expandable Line Set Cover) or equal.

END OF SECTION 01 2300
SECTION 01 2900 - PAYMENT PROCEDURES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.3 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.

1.4 SCHEDULE OF VALUES
   A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule

1.5 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 Architect and paid for by Owner.
1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Times: Submit Application for Payment to Architect by the last day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.

1. Submit draft copy of Application for Payment [seven] days prior to due date for review by Architect.

D. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.

E. Application for Payment Forms: Use forms provided by Owner for Applications for Payment. Sample copies are included in Project Manual.

F. Application for Payment Forms: Use forms acceptable to Architect and Owner for Applications for Payment. Submit forms for approval with initial submittal of schedule of values.

G. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.

H. 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.

I. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

J. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

K. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
5. Waiver Forms: Submit executed waivers of lien on forms, acceptable to Owner.

L. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of values.
3. Contractor's construction schedule (preliminary if not final).
4. Products list (preliminary if not final).
5. Submittal schedule (preliminary if not final).

M. Application for Payment at Substantial Completion: After Architect 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.
2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

N. 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. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 2900
SECTION 01 3300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Processing Time: Allow time for submittal review, including time for resubmittals. 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.

C. Paper Submittals: Place a permanent label or title block on each submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space on label or beside title block to record Contractor's review and approval markings and action taken by Architect/Engineer.
3. Include the following information for processing and recording action taken:

   a. Project name.
   b. Date.
   c. Name of Architect/Engineer.
   d. Name of Contractor.
   e. Name of subcontractor.
   f. Name of supplier.
   g. Name of manufacturer.
   h. Submittal number or other unique identifier, including revision identifier.

   1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

   i. Number and title of appropriate Specification Section.
   j. Drawing number and detail references, as appropriate.
   k. Location(s) where product is to be installed, as appropriate.
   l. Other necessary identification.
4. Additional Paper Copies: Unless additional copies are required for final submittal, and
unless Architect observes noncompliance with provisions in the Contract Documents,
initial submittal may serve as final submittal.

   a. Submit one copy of submittal to concurrent reviewer in addition to specified
      number of copies to Architect.

5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately
   for transmittal and handling. Transmit each submittal using a transmittal form. 
   Architect/Engineer will return without review submittals received from sources other
   than Contractor.

   a. Transmittal Form for Paper Submittals: Provide locations on form for the
      following information:

      1) Project name.
      2) Date.
      3) Destination (To:).
      4) Source (From:).
      5) Name and address of Architect/Engineer.
      6) Name of Construction Manager.
      7) Name of Contractor.
      8) Name of firm or entity that prepared submittal.
      9) Names of subcontractor, manufacturer, and supplier.
      10) Category and type of submittal.
      11) Submittal purpose and description.
      12) Specification Section number and title.
      13) Specification paragraph number or drawing designation and generic name
          for each of multiple items.
      14) Drawing number and detail references, as appropriate.
      15) Indication of full or partial submittal.
      16) Transmittal number [numbered consecutively].
      17) Submittal and transmittal distribution record.
      18) Remarks.
      19) Signature of transmitter.

D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as
   follows:

   1. Assemble complete submittal package into a single indexed file incorporating submittal
      requirements of a single Specification Section and transmittal form with links enabling
      navigation to each item.
   2. Name file with submittal number or other unique identifier, including revision identifier.

      a. File name shall use project identifier and Specification Section number followed
         by a decimal point and then a sequential number (e.g., LNHS-061000.01). 
         Resubmittals shall include an alphabetic suffix after another decimal point (e.g.,
         LNHS-061000.01.A).

   3. Provide means for insertion to permanently record Contractor's review and approval
      markings and action taken by Architect.
4. Transmittal Form for Electronic Submittals: Use **electronic form** acceptable to Owner, containing the following information:

   a. Project name.
   b. Date.
   c. Name and address of Architect/Engineer.
   d. Name of Construction Manager.
   e. Name of Contractor.
   f. Name of firm or entity that prepared submittal.
   g. Names of subcontractor, manufacturer, and supplier.
   h. Category and type of submittal.
   i. Submittal purpose and description.
   j. Specification Section number and title.
   k. Specification paragraph number or drawing designation and generic name for each of multiple items.
   l. Drawing number and detail references, as appropriate.
   m. Location(s) where product is to be installed, as appropriate.
   n. Related physical samples submitted directly.
   o. Indication of full or partial submittal.
   p. Transmittal number **numbered consecutively**.
   q. Submittal and transmittal distribution record.
   r. Other necessary identification.
   s. Remarks.

5. Metadata: Include the following information as keywords in the electronic submittal file metadata:

   a. Project name.
   b. Number and title of appropriate Specification Section.
   c. Manufacturer name.
   d. Product name.

E. Options: Identify options requiring selection by Architect/Engineer.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

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 Architect's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect’s action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Submit electronic submittals via email as PDF electronic files.


2. Action Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect will return two copies.

3. Informational Submittals: Submit two paper copies of each submittal unless otherwise indicated. Architect will not return copies.

4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

   a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.

   b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:

   a. Manufacturer's catalog cuts.

   b. Manufacturer's product specifications.

   c. Standard color charts.

   d. Statement of compliance with specified referenced standards.

   e. Testing by recognized testing agency.

   f. Application of testing agency labels and seals.

   g. Notation of coordination requirements.

   h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:
a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:
   a. PDF electronic file.
   b. Three paper copies of Product Data unless otherwise indicated. Architect/Engineer will return two copies.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Identification of products.
   b. Schedules.
   c. Compliance with specified standards.
   d. Notation of coordination requirements.
   e. Notation of dimensions established by field measurement.
   f. Relationship and attachment to adjoining construction clearly indicated.
   g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
3. Submit Shop Drawings in the following format:
   a. PDF electronic file.
   b. Two opaque (bond) copies of each submittal. Architect/Engineer will return one copy.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:
   a. Generic description of Sample.
   b. Product name and name of manufacturer.
   c. Sample source.
   d. Number and title of applicable Specification Section.
   e. Specification paragraph number and generic name of each item.
3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.

4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

   a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
   
   b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

   a. Number of Samples: Submit [one] full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect/Engineer will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

   a. Number of Samples: Submit three sets of Samples. Architect/Engineer will retain two Sample sets; remainder will be returned. **Mark up and retain one returned Sample set as a project record sample.**

   1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
   2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least [three] sets of paired units that show approximate limits of variations.

E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents 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.
5. Submit product schedule in the following format:
OGDEN HIGH SCHOOL
BOILER AND ROTC BUILDING HVAC REPLACEMENT

a. PDF electronic file.
b. Three paper copies of product schedule or list unless otherwise indicated. Architect/Engineer will return two copies.

F. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects/engineers and owners, and other information specified.

G. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

H. 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.

I. 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.

J. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

K. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

L. 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.

M. 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.

N. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

O. 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.
P. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

Q. 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.

R. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect/Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file and three 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.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect/Engineer.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
3.2 ARCHITECT'S/ENGINEERS ACTION

A. Action Submittals: Architect/Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

B. Informational Submittals: Architect/Engineer will review each submittal and will not return it or will return it if it does not comply with requirements. Architect/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 Architect/Engineer.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Architect/Engineer without action.

END OF SECTION 01 3300
SECTION 01 7700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.4 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, final completion construction photographic documentation, 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 Architect. Label with manufacturer's name and model number where applicable.
   
   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 Architect's signature for receipt of submittals.
   
5. Submit test/adjust/balance records.
6. 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. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   3. Complete startup and testing of systems and equipment.
   4. Perform preventive maintenance on equipment used prior to Substantial Completion.
   5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
   6. Advise Owner of changeover in heat and other utilities.
   7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
   8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   9. Complete final cleaning requirements, including touchup painting.
   10. Touch up 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, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

   1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for final completion.

1.5 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 according to Section 012900 "Payment Procedures."

2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. 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.

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, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.6 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
   a. Project name.
   b. Date.
   c. Name of Architect
   d. Name of Contractor.
   e. Page number.

1.7 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 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.

4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

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.

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
   a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 01 7700
SECTION 01 9000 - CERTIFICATE OF SUBSTANTIAL COMPLETION

INSTITUTION Ogden School District

PROJECT Ogden High School Boiler and ROTC HVAC Replacement

CONTRACTOR

The work performed under the subject contract has been reviewed on this date and is found to be substantially complete. The date of Substantial completion of the project is hereby established to be:

DATE:

which is also the date of commencement of all applicable warranties and guarantees required by the Contract Documents.

When all documents required by the Contract Documents are submitted and approved by the Owner, the Architect will issue a certificate authorizing final payment.

The Owner accepts the Project for occupancy and agrees to assume full responsibility for maintenance and/or exceptions noted below.

A list of items to be completes or corrected, prepared by the Architect and verified by the Owner is appended hereto. This “punchlist” may not be exhaustive, and the failure to include an item on it does not alter the responsibility of the Contractor in complete all the Work in accordance with the Contract Document, including authorized changes thereof. Punch list is complete.

“Substantial Completion” is hereby defined as when the project or specified area of a project is sufficiently completed in accordance with the Contract Documents, as modified by and change orders agreed to by the Parties, so that the Owner can occupy the project or specified area of the project for the use for which it was including, but not limits to, the balancing, testing and fully operational mechanical, electrical, sound, and all other utility and non-utility systems.

The Contractor shall complete or correct the Work on the list of items appended hereto within 14 days from the above date of issuance of this Certificate.

Contractor (include name of firm) ______________________ Signature ______________________ Date 

Van Boerum & Frank Associates, Inc. ______________________ Signature ______________________ Date

Architect

Ogden School District ______________________ Signature ______________________ Date

Owner
SECTION 23 0100 - MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. The General Conditions of the Contract, with the amendments, supplements, forms and requirements in Division 1, and herewith made a part of this Division.

B. All sections of Division 21, 22, & 23 shall comply with the Mechanical General Requirements. The standards established in this section as to quality of materials and equipment, the type and quality of workmanship, mode of operations, safety rules, code requirements, etc., shall apply to all sections of this Division as though they were repeated in each Division.

C. Mechanical equipment that is pre-purchased if any will be assigned to the Mechanical Contractor. By assignment to the Mechanical Contractor, the Mechanical Contractor shall accept and install the equipment and provide all warranties and guarantees as if the Mechanical Contractor had purchased the equipment.

D. Construction Indoor-Air Quality Management
   1. Comply with SMACNA’s “SMACNA IAQ Guideline for Occupied Buildings under Construction.”
      a. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section “Temporary Facilities and Controls,” install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
      b. Replace all air filters immediately prior to occupancy.

1.2 SCOPE OF WORK

A. The project described herein is the Ogden High School Boiler and ROTC Building HVAC Replacement, this work shall include all labor, materials, equipment, fixtures, and devices for the entire mechanical work and a complete operating and tested installation as required for this project.

B. This Division will schedule the boiler inspection and pay for all costs associated with certifying the boiler with the state.

1.3 CODES & ORDINANCES

A. All work shall be executed in accordance with all underwriters, public utilities, local and state rules and regulations applicable to the trade affected. Should any change in the plans and Specifications be required to comply with these regulations, the Contractor shall notify the Architect before the time of submitting his bid. After entering into contract, the Contractor will be held to complete all work necessary to meet these requirements without extra expense to the Owner. Where work required by drawings or specifications is above the standard required, it shall be done as shown or specified.
B. Applicable codes:

1.4 INDUSTRY STANDARDS

A. All work shall comply with the following standards.
1. Associated Air Balance council (AABC)
2. Air Conditioning and Refrigeration Institute (ARI)
3. Air Diffusion council (ADC)
4. Air Movement and Control Association (AMCA)
5. American Gas Association (AGA)
6. American National Standards Institute (ANSI)
7. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
8. American Society of Mechanical Engineers (ASME)
10. American Water Works Association (AWWA)
11. Cooling Tower Institute (CTI)
12. ETL Testing Laboratories (ETL)
13. Institute of Electrical and Electronic Engineers (IEEE)
14. Hydronics Institute (HI)
15. Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
17. National Electrical Code (NEC)
18. National Electrical Manufacturers Association (NEMA)
21. Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA)
22. Underwriters Laboratories (UL)
23. Tubular Exchanger Manufacturers Association, Inc. (TEMA)
24. Heat Exchanger Institute (HEI)
25. Hydraulic Institute (HI)
26. Thermal Insulation Manufacturer’s Association (TIMA)
27. Scientific Apparatus Makers Association (SAMA)

B. Compliance Verification:
1. All items required by code or specified to conform to the ASME code shall be stamped with the ASME seal.
2. Form U-1, the manufacturer=s data report for pressure vessels, is to be included in the Operation and Maintenance Manuals. National Board Register (NBR) numbers shall be provided where required by code.
3. Manufactured equipment which is represented by a UL classification and/or listing, shall bear the UL or equivalent ETL label.
1.5 UTILITIES & FEES

A. All fees for permits required by this work will be paid by this division. The contractor shall obtain the necessary permits to perform this work. Unless noted otherwise, all systems furnished and or installed by this Contractor, shall be complete with all utilities, components, commodities and accessories required for a fully functioning system. This Contractor shall furnish smoke generators when required for testing, furnish glycol for glycol piping systems, full load of salt to fill brine tank for water softening system, furnish cleaners and water treatment additives.

1.6 SUBMITTALS AND SHOP DRAWINGS

A. General: As soon as possible after the contract is awarded, but in no case more than 45 calendar days thereafter, the Contractor shall submit to the Architect manufacturer’s data on products and materials to be used in the installation of mechanical systems for this project. The review of the submitted data will require a minimum of 14 days. The first day starts after the day they are received in the engineer’s office to which the project is being constructed from. If the Contractors schedule requires return of submitted literature in less than the allotted time, the Contractor shall accelerate his submittal delivery date. The Contractor shall resubmit all items requiring re-review within 14 days of returned submittals. Refer to each specification section for items requiring submittal review. If the re-submittal is returned a 2nd time for correction the Contractor will provide the specific equipment that is specified on the drawings and/or the specifications. Written approval of the Owner’s Representative shall be obtained before installing any such equipment or materials for the project.

B. Review by the Owner's Representative is for general conformance of the submitted equipment to the project specification. In no way does such review relieve this Contractor of his obligation to furnish equipment and materials that comply in detail to the specification nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions that may affect his work. Regardless of any items overlooked by the submittal review, the requirements of the contract drawings and specifications must be followed and are not waived or superseded in any way by the review.

C. By description, catalog number, and manufacturer's names, standards of quality have been established by the Architect and the Engineer for certain manufactured equipment items and specialties that are to be furnished by this Division. Alternate products and equipment may be proposed for use only if specifically named in the specifications or if given written prior approval in published addenda. Design equipment is the equipment listed on the drawings or if not listed on the drawings is the equipment first named in the specifications.

D. If the Engineer is required to do additional design work to incorporate changes caused by submitting equipment or products, different than the design equipment specified, as defined above, the contractor shall reimburse the engineer for additional time and expenses at the engineer’s current, recognized, hourly rates.

E. Submittal Format: At the contractor’s discretion, project submittals may be in either of the formats described in the following paragraphs, but mixing the two formats is not acceptable.

1. Hardcopy Submittal Format: Six (6) copies of the descriptive literature covering products and materials to be used in the installation of mechanical systems for this project will be provided for review. The submittals shall be prepared in an orderly manner, contained in a
3-ring loose-leaf binder with index and identification tab for each item or group of items and for each specification section. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within **120 days** of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.

a. Submitted literature shall bear the Contractor’s stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.

b. Submitted literature shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.

c. Submitted literature shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.

2. **Electronic Submittal Format:** Identify and incorporate information in each electronic submittal file as follows:

a. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within **120 days** of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.

b. Submitted electronic file shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.

c. Submitted electronic file shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.

d. Submitted electronic file shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.

e. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.

f. Name file with submittal number or other unique identifier, including revision identifier.

g. **Electronic file shall be completely bookmarked and electronically searchable or it will be rejected.**

h. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by:
1) **Architect.**

i. Transmittal Form for Electronic Submittals:

1) Use one of the following options acceptable to the Owner;

   a) **Software-generated form from electronic project management software.**

   b) **Electronic form.**

2) The Electronic Submittal shall contain the following information:

   a) Project name.

   b) Date.

   c) Name and address of Architect.

   d) Name of Construction Manager.

   e) Name of Contractor.

   f) Name of firm or entity that prepared submittal.

   g) Names of subcontractor, manufacturer, and supplier.

   h) Category and type of submittal.

   i) Submittal purpose and description.

   j) Specification Section number and title.

   k) Specification paragraph number or drawing designation and generic name for each of multiple items.

   l) Drawing number and detail references, as appropriate.

   m) Location(s) where product is to be installed, as appropriate.

   n) Related physical samples submitted directly.

   o) Indication of full or partial submittal.

   p) Transmittal number[, numbered consecutively].

   q) Submittal and transmittal distribution record.

   r) Other necessary identification.

   s) Remarks.

j. Metadata: Include the following information as keywords in the electronic submittal file metadata:

   1) Project name.

   2) Number and title of appropriate Specification Section.

   3) Manufacturer name.

   4) Product name.

1.7 **DRAWINGS AND MEASUREMENTS**

A. **Construction Drawings:** The contract document drawings show the general design, arrangements, and extent of the system. In certain cases, the drawings may include details that show more nearly exact locations and arrangements; however, the locations, as shown diagrammatically, are to be regarded as general.

B. It shall be the work of this Section to make such slight alterations as may be necessary to make adjustable parts fit to fixed parts, leaving all complete and in proper shape when done. All dimensions given on the drawings shall be verified as related to this work and with the Architect’s office before work is started.
C. This Section shall carefully study building sections, space, clearances, etc., and then provide offsets in piping or ductwork as required to accommodate the building structure without additional cost to the Owner. In any case and at any time during the construction process, a change in location required by obstacles or the installation of other trades not shown on the mechanical plans shall be made without charge.

D. The drawings shall not be scaled for roughing in measurements nor shall they be used as shop drawings. Where drawings are required for these purposes or where drawings must be made from field measurements, the Contractor shall take the necessary measurements and prepare the drawings. Shop drawings of the various subcontractors shall be coordinated to eliminate all interferences and to provide sufficient space for the installation of all equipment, piping, ductwork, etc.

E. The drawings and specifications have been prepared to supplement each other and they shall be interpreted as an integral unit with items shown on one and not the other being furnished and installed as though shown and called out on both.

F. Coordination Drawings: The contractor shall provide coordination drawings for mechanical rooms, fan rooms, equipment rooms, and congested areas to eliminate conflicts with equipment, piping, or work of other trades. The drawings shall be a minimum scale of 1/4 inch = 1 foot and of such detail as may be required by the Engineer to fully illustrate the work. These drawings shall include all piping, conduit, valves, equipment, and ductwork.

G. Sheet-metal shop drawings will be required for all ductwork in the entire building. These drawings will show all ductwork in the entire building and shall be coordinated with architectural, structural and electrical portions of the project. The contractor shall specifically obtain copies of the structural shop drawings and shall coordinate the ductwork shop drawings with approved structural members. These drawings shall be submitted to the engineer for review prior to any fabrication. The contractor is responsible for all modifications necessary to accommodate duct installation within the structural, architectural and electrical restrictions. These drawings, once reviewed by the engineer, will be made available to all mechanical, electrical, and fire sprinkler subcontractors to coordinate installation of their work.

1.8 CONTRACTOR'S USE OF BUILDING EQUIPMENT

A. The Contractor may use equipment such as electric motors, fans, heat exchangers, filters, etc., with the written permission of the Owner. As each piece of equipment is used (such as electric motors and fans), maintenance procedures approved by the manufacturer are to be followed. A careful record is to be kept of the length of the time the equipment is used, maintenance procedures followed, and any difficulty encountered. The record is to be submitted to the Owner upon acceptance. All fan belts and filter media (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement. New filter media shall be installed in air handlers at the time systems are turned over to the owner.

1.9 EXISTING CONDITIONS

A. The Contractor shall carefully examine all existing conditions that might affect the mechanical system and shall compare these conditions with all drawings and specifications for work included under this contract. He shall, at such time, ascertain and check all conditions that may affect his
work. No allowance shall subsequently be made in his behalf for an extra expense incurred as a result of his failure or neglect to make such examination. This Contractor shall include in his bid proposal all necessary allowances to repair or replace any item that will remain or will be removed, and any item that will be damaged or destroyed by new construction.

B. The Contractor shall remove all abandoned piping, etc., required by new construction and cap or plug openings. No capping, etc., shall be exposed in occupied areas. All openings of items removed shall be sealed to match adjacent surfaces.

C. The Contractor shall verify the exact location of all existing services, utilities, piping, etc., and make connections to existing systems as required or as shown on the drawings. The exact location of each utility line, together with size and elevation, shall be established before any on-site lines are installed. Should elevation or size of existing main utility lines make connections to them impossible as shown on drawings, then notification of such shall immediately be given to the Owners Representative for a decision.

1.10 EQUIPMENT CAPACITIES

A. Capacities shown for equipment in the specifications and on the drawings are the minimum acceptable. No equipment shall be considered as an alternate that has capacities or performance less than that of design equipment.

B. All equipment shall give the specified capacity and performance at the job-site elevation. Manufacturers' standard ratings shall be adjusted accordingly. All capacities and performances listed on drawings or in specifications are for job-site conditions.

1.11 SEISMIC REQUIREMENTS FOR EQUIPMENT

A. All equipment shall be furnished structurally adequate to withstand seismic forces as outlined in the International Building Code. Refer to section Mechanical Vibration Controls and Seismic Restraints. Equipment bases shall be designed for direct attachment of seismic snubbers and/or seismic anchors.

1.12 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other drawings and parts of this specification that cover work of other trades that is carried on in conjunction with the mechanical work such that all work can proceed without interference resulting from lack of coordination.

B. The Contractor shall properly size and locate all openings, chases, sleeves, equipment bases, and accesses. He shall provide accurate wiring diagrams to the Electrical Contractor for all equipment furnished under this Division.

C. The ceiling cavity must be carefully reviewed and coordinated with all trades. In the event of conflict, the installation of the mechanical equipment and piping shall be in the following order: plumbing, waste, and soil lines; supply, return, and exhaust ductwork; water piping; medical gases; fire protection piping; and pneumatic control piping.
D. The mechanical Contractor shall insure that the installation of all piping, ducts and equipment is in compliance with Articles 110-16 and 384-4 of the National Electrical Code relative to proper clearances in front of and over all electrical panels and equipment. No piping or ductwork will be allowed to run over electrical panel.

1.13 RESPONSIBILITY OF CONTRACTOR

A. The Contractor is responsible for the installation of a satisfactory piece of work in accordance with the true intent of the drawings and specifications. He shall provide, as a part of his work and without expense, all incidental items required even though these items are not particularly specified or indicated. The installation shall be made so that its several component parts will function together as a workable system and shall be left with all equipment properly adjusted and in working order. The Contractor shall familiarize the Owner's Representative with maintenance and lubrication instructions as prepared by the Contractor and shall explain and fully instruct him relative to operating, servicing, and maintenance of them.

B. If a conflict arises between the drawings and the specifications the most stringent procedure/action shall be followed. A clarification to the engineer will help to determine the course of action to be taken. If a conflict arises between specification sections the engineer will determine which course of action is to be followed.

1.14 PIPE AND DUCT OPENINGS AND EQUIPMENT RECESSES

A. Pipe and duct chases, openings, and equipment recesses shall be provided by others only if shown on architectural or structural drawings. All openings for the mechanical work, except where plans and specifications indicate otherwise, shall be provided as work of this Division. Include openings information with coordination drawings.

B. Whether chases, recesses, and openings are provided as work of this Division or by others, this Contractor shall supervise their construction and be responsible for the correct size and location even though detailed and dimensioned on the drawings. This Contractor shall pay for all necessary cutting, repairing, and finishing if any are left out or incorrectly made. All necessary openings thru existing walls, ceilings, floors, roofs, etc. shall be provided by this Contractor unless indicated otherwise by the drawing and/or specifications.

1.15 UNFIT OR DAMAGED WORK

A. Any part of this installation that fails, is unfit, or becomes damaged during construction, shall be replaced or otherwise made good. The cost of such remedy shall be the responsibility of this Division.

1.16 WORKMANSHIP

A. Workmanship shall be the best quality of its kind for the respective industries, trades, crafts, and practices, and shall be acceptable in every respect to the Owner's representative. Nothing contained herein shall relieve the Contractor from making good and perfect work in all details in construction.
1.17 SAFETY REGULATION

A. The Contractor shall comply with all local, Federal, and OSHA safety requirements in performance with this work. (See General Conditions). This Contractor shall be required to provide equipment, supervision, construction, procedures, and all other necessary items to assure safety to life and property.

1.18 ELECTRICAL SERVICES

A. All equipment control wiring and all automatic temperature control wiring including all necessary contacts, relays, and interlocks, whether low or line voltage, except power wiring, shall be furnished and installed as work of this Division unless shown to be furnished by Division 26. All such wiring shall be in conduit as required by electrical codes. Wiring in the mechanical rooms, fans rooms and inaccessible ceilings and walls shall be installed in conduit as well. Installation of any and all wiring done under Division 21, 22 and 23 shall be in accordance with the requirements of Division 26, Electrical.

B. All equipment that requires an electrical connection shall be furnished so that it will operate properly and deliver full capacity on the electrical service available.

C. Refer to the electrical control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment.

D. The Mechanical Contractor must coordinate with the Electrical Contractor to insure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.19 WORK, MATERIALS, AND QUALITY OF EQUIPMENT

A. Unless otherwise specified, all materials shall be new and of the best quality of their respective kinds and all labor shall be done in a most thorough and workmanlike manner.

B. Products or equipment of any of the manufacturers cited herein or any of the products approved by the Addenda may be used. However, where lists of products are cited herein, the one first listed in the design equipment used in drawings and schedules to establish size, quality, function, and capacity standards. If other than design equipment is used, it shall be carefully checked for access to equipment, electrical and control requirements, valving, and piping. Should changes or additions occur in piping, valving, electrical work, etc., or if the work of other Contractors would be revised by the alternate equipment, the cost of all changes shall be borne as work of this Division.

C. The Execution portions of the specifications specify what products and materials may be used. Any products listed in the Product section of the specification that are not listed in the Execution portion of the specification may not be used without written approval by the Engineer.

D. The access to equipment shown on the drawings is the minimum acceptable space requirements. No equipment that reduces or restricts accessibility to this or any other equipment will be considered.
E. All major items of equipment are specified in the equipment schedules on the drawings or in these specifications and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory installation.

F. All welders shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, latest Edition.

1.20 PROTECTION AGAINST WEATHER AND STORING OF MATERIALS

A. All equipment and materials shall be properly stored and protected against moisture, dust, and wind. Coverings or other protection shall be used on all items that may be damaged or rusted or may have performance impaired by adverse weather or moisture conditions. Damage or defect developing before acceptance of the work shall be made good at the Contractor's expense.

B. All open duct and pipe openings shall be adequately covered at all times.

1.21 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule and the seismic supplier shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.

B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it operated satisfactorily.

C. All costs for this work shall be included in the prices quoted by equipment suppliers.

1.22 EQUIPMENT LUBRICATION

A. The Contractor shall properly lubricate all pieces of equipment before turning the building over to the Owner. A linen tag shall be attached to each piece of equipment, showing the date of lubrication and the lubricant used. No equipment shall be started until it is properly lubricated.

B. Necessary time shall be spent with the Owner's Representative to thoroughly familiarize him with all necessary lubrications and maintenance that will be required of him.

C. Detergent oil as used for automotive purposes shall not be used for this work.
1.23 CUTTING AND PATCHING

A. No cutting or drilling in structural members shall be done without written approval of the Architect. The work shall be carefully laid out in advance, and cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces necessary for the mechanical work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by professional plasterers, masons, concrete workers, etc., and all such work shall be paid for as work of this Division.

B. When concrete, grading, etc., is disturbed, it shall be restored to original condition as described in the applicable Division of this Specification.

1.24 EXCAVATION AND BACKFILLING

A. All necessary excavations and backfilling for the Mechanical phase of this project shall be provided as work of this Division. Trenches for all underground pipelines shall be excavated to the required depths. The bottom of trenches shall be compacted hard and graded to obtain required fall. Backfill shall be placed in horizontal layers, not exceeding 12 inches in thickness, and properly moistened. Each layer shall be compacted, by suitable equipment, to a density of not less than 95 percent as determined by ASTM D-1557. After pipelines have been tested, inspected, and approved, the trench shall be backfilled with selected material. Excess earth shall be hauled from the job site. Fill materials approved by the Architect shall be provided as work of this Division.

B. No trenches shall be cut near or under any footings without consultation first with the Architect's office. Any trenches or excavations more than 30 inches deep shall be tapered, shored, covered, or otherwise made absolutely safe so that no vehicle or persons can be injured by falling into such excavations, or in any way be harmed by cave-ins, shifting earth, rolling rocks, or by drowning. This protection shall be extended to all persons approaching excavation related to this work whether or not such persons are authorized to be in the vicinity of the construction.

1.25 ACCESS

A. Provide access doors in walls, ceilings and floors by this division unless otherwise noted. For access to mechanical equipment such as valves, dampers, fan coils, fans, controls, etc. All access doors shall be 24" x 24" unless otherwise indicated or required. Coordinate location of doors with the Architect prior to installation. Doors in ceilings and wall shall be equal to JR Smith No. 4760 bonderized and painted. Doors in tile walls shall be equal to JR Smith No. 4730 chrome plated. Doors in floors shall be equal to JR Smith No. 4910

B. Valves: Valve must be installed in locations where access is readily available. If access is compromised, as judged by the Mechanical Engineer, these valves shall be relocated where directed at the Contractors expense.

C. Equipment: Equipment must be installed in locations and orientations so that access to all components requiring service or maintenance will not be compromised. If access is compromised, as judged by the Mechanical Engineer, the contractor shall modify the installation as directed by the Engineer at the Contractors expense.
D. It is the responsibility of this division to install terminal boxes, valves and all other equipment and
devices so they can be accessed. If any equipment or devices are installed so they cannot be
accessed on a ladder a catwalk and ladder system shall be installed above the ceiling to access and
service this equipment.

1.26 CONCRETE BASES AND INSERTS

A. Bases: The concrete bases shall be provided and installed as work by this division. This Division
shall be responsible for the proper size and location of bases and shall furnish all required anchor
bolts and sleeves with templates to be installed as work of Division 3, Concrete.

B. All floor-mounted mechanical equipment shall be set on 6-inch high concrete bases, unless
otherwise noted or shown on drawings. Such bases shall extend 6 inches beyond equipment or
mounting rails on all sides or as shown on the drawings and shall have a 1-inch beveled edge all
around.

C. Inserts: Where slotted or other types of inserts required for this work are to be cast into concrete,
they shall be furnished as work of this Division

D. Concrete inserts and pipe support systems shall be equal to Unistrut P3200 series for all piping
where more than one pipe is suspended at a common location. Spacing of the inserts shall match
the size and type of pipe and of ductwork being supported. The Unistrut insert and pipe support
system shall include all inserts, vertical supports, horizontal support members, clamps, hangers,
rollers, bolts, nuts, and any other accessory items for a complete pipe-supporting system.

1.27 CLEANING AND PAINTING

A. Cleaning: After all tests and adjustments have been made and all systems pronounced satisfactory
for permanent operation, this Contractor shall clean all exposed piping, ductwork, insulated
members, fixture, and equipment installed under this Section and leave them ready for painting. He
shall refinish any damaged finish and leave everything in proper working order. The Contractor
shall remove all stains or grease marks on walls, floors, glass, hardware, fixtures, or elsewhere,
caused by his workman or for which he is responsible. He shall remove all stickers on plumbing
fixtures, do all required patching up and repair all work of others damaged by this division of the
work, and leave the premises in a clean and orderly condition.

B. Painting: Painting of exposed pipe, insulated pipe, ducts, or equipment is work of Division 9,
Painting.

C. Mechanical Contractor: All equipment which is to be furnished in factory prefinished conditions by
the mechanical Contractor shall be left without mark, scratch, or impairment to finish upon
completion of job. Any necessary refinishing to match original shall be done. Do not paint over
nameplates, serial numbers, or other identifying marks.

D. Removal of Debris, Etc: Upon completion of this division of the work, remove all surplus material
and rubbish resulting from this work, and leave the premises in a clean and orderly condition.
1.28 CONTRACT COMPLETION

A. Incomplete and Unacceptable Work: If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.

B. Maintenance Instructions: The Contractor shall furnish the Owner complete printed and illustrated operating and maintenance instructions covering all units of mechanical equipment, together with parts lists.

C. Instructions To Owner's Representatives: In addition to any detailed instructions called for, the mechanical Contractor must provide, without expense to the Owner, competent instructors to train the Owner's representatives who will be in charge of the apparatus and equipment, in the care, adjustment, and operation of all parts on the heating, air conditioning, ventilating, plumbing, fire protection, and automatic temperature control equipment. Instruction dates shall be scheduled at time of final inspection. A written report specifying times, dates, and name of personnel instructed shall be forwarded to the Architect. A minimum of four 8-hour instruction periods shall be provided. The instruction periods will be broken down to shorter periods when requested by the Owner. The total instruction hours shall not be reduced. The ATC Contractor shall provide 4 hours of instructions. The remaining hours shall be divided between the mechanical and sheet metal Contractor.

D. Guarantee: By the acceptance of any contract award for the work herein described or shown on the drawings, the Contractor assumes the full responsibility imposed by the guarantee as set forth herein and in the General Conditions, and should protect himself through proper guarantees from equipment and special equipment Contractors and from subcontractors as their interests may appear.

E. The guarantee so assumed by the Contractor and as work of this Section is as follows:
1. That the entire mechanical system, including plumbing, heating, and air-conditioning system shall be quiet in operation.
2. That the circulation of water shall be complete and even.
3. That all pipes, conduit, and connections shall be perfectly free from foreign matter and pockets and that all other obstructions to the free passage of air, water, liquid, sewage, and vent shall be removed.
4. That he shall make promptly and free of charge, upon notice from the Owner, any necessary repairs due to defective workmanship or materials that may occur during a period of one year from date of Substantial Completion.
5. That all specialties, mechanical, and patent devices incorporated in these systems shall be adjusted in a manner that each shall develop its maximum efficiency in the operation of the system; i.e., diffusers shall deliver the designed amount of air shown on drawings, thermostats shall operate to the specified limits, etc.
6. All equipment and the complete mechanical, ductwork, piping and plumbing systems shall be guaranteed for a period of one year from the date of the Architect's Certificate of Substantial Completion, this includes all mechanical, ductwork, piping and plumbing equipment and products and is not limited to boiler, chillers, coils, fans, filters etc. Any equipment supplier not willing to comply with this guarantee period shall not submit a bid price for this project. The Contractor shall be responsible for a 100-percent guarantee for the system and all items of equipment for this period. If the contractor needs to provide temporary heating or cooling to the building and or needs to insure systems are installed...
properly and or to meet the project schedule the guaranteed of all systems and equipment shall be as indicated above, on year from the date of the Architect's Certificate of Substantial Completion.

7. All filters used during construction shall be replaced just before equipment is turned over to the Owner, and all required equipment and parts shall be oiled. Any worn parts shall also be replaced.

8. If any systems or equipment is used for temporary heating or cooling the systems shall be protected so they remain clean. I.e. if the ductwork systems are used temporary filters and a filter holder (not duct-taped to ducts or grilles) shall be installed to insure the systems and the equipment remain clean.

1.29 CURBS

A. Unless otherwise noted in these specifications or on the documents all roof curbs for all equipment are to be provided by Division 22 and 23.

1.30 TEST RUN

A. The Mechanical Contractor shall operate the mechanical system for a minimum of 30 days to prove the operation of the system.

1.31 EQUIPMENT STARTUP AND CHECKOUT:

A. Each major piece of equipment shall be started and checked out by an authorized representative of the equipment manufacturer. A certificate indicating the equipment is operating to the satisfaction of the manufacturer shall be provided and shall be included in the commissioning report.

B. This contractor shall coordinate commissioning procedures and activities with the commissioning agent.

1.32 DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

B. Proceed with 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.

C. 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, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

D. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
E. 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.

F. Maintain adequate ventilation when using cutting torches.

G. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

H. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

I. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

J. Dispose of demolished items and materials promptly.

K. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

L. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

M. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

N. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

O. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

P. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

END OF SECTION 23 0100
PART 1 - GENERAL

1.1 SUMMARY

A. This section includes requirements for temporary use of equipment and systems and any other items that are used during the construction of the project.

1.2 EQUIPMENT OR SYSTEMS NEEDED TO OPERATE BEFORE CONTRACT COMPLETION

A. If the contractor needs to provide temporary heating or cooling to the building and or needs to insure systems are installed properly for start up and or to meet the project schedule the guaranteed of all systems and equipment shall be for one year from the date of the Architect's Certificate of Substantial Completion.

All equipment and the complete mechanical, ductwork, piping and plumbing systems shall be guaranteed for a period of one year from the date of the Architect's Certificate of Substantial Completion, this includes all mechanical, ductwork, piping and plumbing equipment and products and is not limited to boiler, chillers, coils, fans, filters etc. Any contractor or equipment supplier who is not willing to comply with this guarantee period shall not submit a bid price for this project. The Contractor shall be responsible for a 100-percent guarantee for the systems and all items of equipment for this period.

All filters used during construction shall be replaced just before equipment is turned over to the Owner, and all required equipment and parts shall be oiled. Any worn parts shall also be replaced.

If any systems or equipment is used for temporary heating or cooling the systems shall be protected so they remain clean. I.e. if the ductwork systems are used temporary filters and a filter holder (not duct-taped to ducts or grilles) shall be installed to insure the systems and the equipment remain clean. All return air openings shall be protected with a metal filter frame and filters.

1.3 TEMPORARY EQUIPMENT OR SYSTEM SUBMITTALS

A. If it is determined by the project or contractor that equipment or systems are needed to operate to provide heating, cooling or other needed services this division shall submit a document indicating what measures will be taken to insure the safe and proper operation of the equipment, systems and personal associated with the operation, this document shall be submitted to the engineer for approval. This plan shall show connections of equipment, utility hookups (if required) staging areas etc.
1.4 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

D. SMACNA: The latest standard from SSMACNA shall apply.

1.5 PROJECT CONDITIONS

A. Temporary Use of equipment or systems: Engage installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use until the facility has been accepted by the owner regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 EQUIPMENT

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

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters and cooling units if required with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filters with MERV of 8 at each return air opening in system and remove at end of construction. These filters are to be installed in a filter housing frame and are not to be duct taped. Clean HVAC system as required in Division 01 Section "Closeout Procedures."
PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate equipment where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify equipment and systems as required by progress of the Work.

1. Locate equipment to limit site disturbance as specified in Division 01 Section "Summary."

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

C. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

D. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

3.3 OPERATION, TERMINATION, AND REMOVAL

A. Maintenance: Maintain equipment and systems in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar equipment and systems on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

B. Termination and Removal: Remove each temporary facility or equipment 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 equipment that constitute temporary equipment are property of Contractor.
2. At Substantial Completion, repair, renovate, and clean permanent equipment and systems used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

3.4 EQUIPMENT STARTUP AND CHECKOUT:

A. Each major piece of equipment shall be started and checked out by an authorized representative of the equipment manufacturer at substantial completion. A certificate indicating the equipment is operating to the satisfaction of the manufacturer shall be provided and shall be included in the commissioning report.

END OF SECTION 23 0150
SECTION 23 0500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Piping materials and installation instructions common to most piping systems.
      2. Transition fittings.
      3. Dielectric fittings.
      4. Mechanical sleeve seals.
      5. Sleeves.
      7. Grout.
      8. Equipment installation requirements common to equipment sections.
     10. Concrete bases.
     11. Supports and anchorages.
     12. Link-Seal

1.3 DEFINITIONS
   A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, and crawl spaces.
   B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces, mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases, and accessible tunnels.
   C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
   D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
   E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS
   A. Product Data: For the following:
      1. Transition fittings.
      2. Dielectric fittings.
      3. Mechanical sleeve seals.
      4. Escutcheons.
   B. Welding certificates.

1.5 QUALITY ASSURANCE
   A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
   B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
      1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
      2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
   C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. 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.
   B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION
   A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8-inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BA1, silver alloy for refrigerant piping, unless otherwise indicated.
F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
   a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
   a. Thompson Plastics, Inc.

2.5 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.


2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

E. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: **5000-psi**, 28-day compressive strength.

2.10 LINK-SEAL MODULAR SEAL PRESSURE PLATES

A. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
   1. Izod Impact - Notched = **2.05ft-lb/in.**, per ASTM D-256
   2. Flexural Strength @ Yield = **30,750 psi** per ASTM D-790
   3. Flexural Modulus = **1,124,000 psi** per ASTM D-790
   4. Elongation Break = 11.07% per ASTM D-638
   5. Specific Gravity = 1.38 per ASTM D-792

B. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a “Hex Nut Interlock” designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer’s name molded into it.

C. For fire service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.

D. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be:
   1. 316 Stainless Steel per ASTM F593-95, with a **85,000 psi** average tensile strength.
PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble
mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping **NPS 2** and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping **NPS 2-1/2** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. **Dry Piping Systems:** Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. **Wet Piping Systems:** Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

### 3.5 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### 3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch** centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use **3000-psi**, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section “Miscellaneous Cast-in-Place Concrete.”

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.9 LINK SEAL

A. Provide Link Seal at all piping penetrations from the outside.

END OF SECTION 23 0500
SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

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

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

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
A. Comply with requirements in this Section except when the requirements in equipment schedules, other specification sections, drawing notes or in other contract documents are more stringent.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS
A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
C. Motors 3/4 HP and larger: Polyphase.

D. Motors smaller than 3/4 HP: Single phase.

E. All motors shall have ASTM Grade 5 hardware that is Yellow Zinc-dichromate plated.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, 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.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
C. Motors 1/20 HP and Smaller: Shaded-pole type.

D. 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, unless otherwise indicated.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 0513
SECTION 23 0517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Sleeve-seal systems.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.


E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.

      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:


b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:


END OF SECTION 23 0517
SECTION 23 0518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Escutcheons.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated or rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

   1. Escutcheons for New Piping:
a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type with polished, chrome-plated finish.

b. Chrome-Plated Piping: **One-piece, cast-brass** type with polished, chrome-plated finish.

c. Insulated Piping: **One-piece, stamped-steel type with chrome-plated finish.**

d. Bare Piping 2 inch and Smaller at Wall and Floor Penetrations in Finished Spaces: **One-piece, cast-brass** type with polished, chrome-plated finish.

e. Bare Piping Larger than 2 inch at Wall and Floor Penetrations in Finished Spaces: **One-piece, stamped-steel type with polished, chrome-plated finish.**

f. Bare Piping 2 inch and Smaller at Ceiling Penetrations in Finished Spaces: **One-piece, cast-brass** type with polished, chrome-plated finish.

g. Bare Piping Larger than 2 inch at Ceiling Penetrations in Finished Spaces: **One-piece, stamped-steel type with polished, chrome-plated finish.**

h. Bare Piping 2 inch and Smaller in Unfinished Service Spaces: **One-piece, cast-brass.**

i. Bare Piping Larger than 2 inch in Unfinished Service Spaces: **One-piece, stamped-steel type with polished, chrome-plated finish.**

j. Bare Piping 2 inch and Smaller in Equipment Rooms: **One-piece, cast-brass** type with polished, chrome-plated finish.

k. Bare Piping in Equipment Rooms Larger than 2 inch: **One-piece, stamped-steel type with chrome- or cadmium-plated finish.**

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 23 0518
SECTION 23 0519 - METERS AND GAGES FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Test-plug kits.
   7. Flowmeters.

B. Related Sections:
   1. Division 23 Section "Facility Natural-Gas Piping" for gas meters.
   2. Division 23 Section "Steam and Condensate Heating Piping" for steam and condensate meters.

1.3 ACTION SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.
PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   b. Treice, H. O. Co.
   c. Weiss Instruments, Inc.
   d. Weksler.

3. Case: Die Cast aluminum or brass; nominal size unless otherwise indicated.
4. Case Form: Adjustable angle type unless otherwise indicated, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Satin faced, nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Copper-plated steel, aluminum, stainless steel, or brass designed for thermowell installation. Stem shall be of length to match thermowell insertion length.

   a. Design for Thermowell Installation: Bare stem.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMETEK, Inc.; U.S. Gauge Div.
   c. Emst Gage Co.
   d. Marsh Bellofram.
   e. Miljoco Corp.
   f. NANMAC Corporation.
   g. Noshok, Inc.
   h. Palmer - Wahl Instruments Inc.
   i. REO TEMP Instrument Corporation.
   j. Tel-Tru Manufacturing Company.
   k. Treice, H. O. Co.
1. Weiss Instruments, Inc.
2. Manufacturers: Same as manufacturer of thermometer being used.
4. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
5. Material for Use with Copper Tubing: Brass.
7. Type: Stepped shank unless straight or tapered shank is indicated.
8. External Threads: NPS 1/2, NPS 3/4, NPS 1 or NPS 1-1/4 ASME B1.20.1 pipe threads.
9. Internal Threads: 1/2, 3/4, and 1 inch with ASME B1.1 screw threads.
10. Bore: Diameter required to match thermometer bulb or stem.
11. Insertion Length: Length required to match thermometer bulb or stem.
12. Lagging Extension: Include on thermowells for insulated piping and tubing.
13. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Emst Flow Industries.
   d. KOBOLD Instruments, Inc.
   e. Marsh Bellofram.
   f. Miljoco Corporation.
   g. Noshok.
   h. Palmer Wahl Instrumentation Group.
   i. RETEMP Instrument Corporation.
   j. Tercie, H. O. Co.
   k. Weiss Instruments, Inc.
   l. Weksler
   m. WIKA Instrument Corporation.
   n. Winters Instruments - U.S.

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 ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated. NPS 1/4 or NPS 1/2.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Satin faced, nonreflective aluminum with permanently etched scale markings graduated in \textbf{psi}.
10. \textbf{Ring: Stainless steel}.
11. \textbf{Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.}

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Emsl Flow Industries.
   d. KOBOLD Instruments, Inc.
   e. Marsh Bellofram.
   f. Miljoco Corporation.
   g. Noshok.
   h. Palmer Wahl Instrumentation Group.
   i. REOTEMP Instrument Corporation.
   j. Trefice, H. O. Co.
   k. Weiss Instruments, Inc.
   l. Weksler
   m. WIKA Instrument Corporation.
   n. Winters Instruments - U.S.

3. \textbf{Case: Liquid-filled, cast aluminum or drawn steel}; diameter with \textbf{back} flange for panel surface mounting or front flange for panel recessed mounting. Flanges to include pre-drilled screw holes.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated. \textbf{NPS 1/4 or NPS 1/2}.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Satin faced, nonreflective aluminum with permanently etched scale markings graduated in \textbf{psi}.
9. Window: \textbf{Glass}.
10. \textbf{Ring: Stainless steel}.
11. \textbf{Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.}

2.4 \textbf{GAGE ATTACHMENTS}

A. Snubbers: ASME B40.100, brass; with ASME B1.20.1 pipe threads. Include extension for use on insulated piping. \textbf{NPS 1/4 or NPS 1/2}.
   1. \textbf{Surge-dampening device: porous-metal-type}.

B. Siphons:
   1. \textbf{Loop-shaped section: Brass} pipe with pipe threads. \textbf{NPS 1/4 or NPS 1/2}.
C. Valves:
   1. **Needle: Brass**, with **NPS 1/4 or NPS 1/2** ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Flow Design, Inc.
   2. MG Piping Products Co.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Company, Inc.
   6. Tence, H. O. Co.
   7. Twin City Hose.
   8. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: or, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating:

F. Core Inserts: Self-sealing synthetic rubber;
   1. EPDM (Nordel) for air, water or glycol operation between **30 and 275 deg F**.
   2. CR (Neoprene) for air, water, glycol, oil, or gas operation between **-30 to 200 deg F**.

2.6 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Flow Design, Inc.
   2. MG Piping Products Co.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Company, Inc.
   6. Tence, H. O. Co.
   7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   8. Weiss Instruments, Inc.

B. Furnish the number of test-plug kits given below with the number of thermometers given below, with each kit having one pressure gage and adapter, and carrying case. Thermometer sensing
elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

1. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

2. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

3. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least to 200 psig.

4. Carrying Case: Metal or plastic, with formed instrument padding.

5. One test-plug kit with:
   a. Two thermometers.

2.7 FLOWMETERS

A. Orifice Flowmeters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ABB; Instrumentation and Analytical.
   c. Badger Meter, Inc.; Industrial Div.
   d. Bell & Gossett; ITT Industries.
   e. Meriam Process Technologies.
   f. Spirax Sarco

2. Description: Flowmeter with sensor, hoses or tubing, quick connect hose fittings, valves, indicator, and conversion chart.

3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

   a. Design: Differential-pressure-type measurement:
      1) For HVAC hot water.
   b. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
   c. Minimum Pressure Rating: 300 psig.
   d. Minimum Temperature Rating: 250 deg F.

5. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot hoses, with carrying case.
   a. Scale: Gallons per minute.
   b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.


7. Operating Instructions: Include complete instructions with each flowmeter.
B. Venturi Flowmeters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pump
   b. Badger Meter, Inc.; Industrial Division
   c. Bailey-Fischer & Porter Co.
   d. Flow Design, Inc.
   e. Gerand Engineering Co.
   f. Hyspan Precision Products, Inc.
   g. Leeds & Northrup.
   h. McCrometer, Inc.
   i. Preso Meters; a division of Racine Federated Inc.
   j. Victaulic Company.
   k. Spirax Sarco

2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, quick connect hose fittings, valves, indicator, and conversion chart.

3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.


   a. **Design:** Differential-pressure-type measurement for water.
   b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
   c. Minimum Pressure Rating: **250 psig** .
   d. Minimum Temperature Rating: **250 deg F** .
   e. End Connections for **NPS 2** and Smaller: Threaded.
   f. End Connections for **NPS 2-1/2** and Larger: Flanged or welded.
   g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.

**PART 3 - EXECUTION**

3.1 **INSTALLATION**

   A. **Install thermowells:** with socket extending **one-third of pipe diameter** and in vertical position in piping tees.

   B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

   C. Install thermowells with extension on insulated piping.

   D. Fill thermowells with heat-transfer medium.

   E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions to most readable position.
F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install needle-valve and snubber in piping for each pressure gage for fluids. Exception: Steam.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic boiler.
   2. Inlet and outlet of each hydronic coil in air-handling units.

J. Install pressure gages in the following locations:
   1. Inlet and discharge of each pressure-reducing valve.
   2. Suction and discharge of each pump.

3.2 CONNECTIONS

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

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:

B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
   1. Industrial-style, liquid-in-glass type.

C. Thermometers at inlet and outlet of each hydronic coil at Make-up Air Unit systems shall be one of the following:
   1. Industrial-style, liquid-in-glass type.

D. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.
3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at inlet and discharge of each pressure-reducing valve shall be the one of following:

1. Dry-case type, direct-mounted, metal case.

B. Pressure gages at suction and discharge of each pump shall be one of the following:

1. **Liquid-filled**, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping shall be twice the normal operating pressure of the measured system with gage ranges as follows:

1. **30 in. Hg to 15 psi**.
2. 0 to 30 psi.
3. 0 to 100 psi.
4. 0 to 160 psi.
5. 0 to 200 psi.
6. 0 to 300 psi.
7. 0 to 600 psi.

3.8 FLOWMETER SCHEDULE

A. Flowmeters for Heating, Hot-Water Piping: **Venturi** type.

END OF SECTION 23 0519
SECTION 23 0523 - GENERAL-DUTYVALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
7. Lubricated plug valves.
8. Chainwheels.

B. Related Sections:

1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.
1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated. Body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.

B. Maintenance data for valves to be included in the operation and maintenance data specified in Division 1. Include detailed manufacturer’s instructions on adjusting, servicing, disassembling, and repairing.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve as listed in SUMMARY from a single source and from a single manufacturer.

B. Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.
   4. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.
   3. Set angle, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
   4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
   5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Solder Joint: With sockets according to ASME B16.18.
      a. **Caution:** Where soldered end connections are used, use solder having a melting point below 840 deg. For, globe, and check valves: below 421 deg. F for ball valves.
   3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. APCO Willamette Valve and Primer Corp.
   2. Babbitt Steam Specialty Company.
   3. Bray Controls.
   4. Center Line.
   5. Cla-Val Company.
6. Conbraco Industries Inc., Apollo Valves
7. Crane Co.; Crane Valve Group.
8. Fisher Valve by Emerson.
9. Flo Fab Inc.
10. Flow-Tek Inc.
13. Jamesbury; a subsidiary of Metso Automation.
14. Jomar International LTD.
15. Keystone Valve USA, Inc.
16. Kitz Corp.
17. Metraflex Company.
18. Milwaukee Valve Company.
20. NIBCO Inc.
21. Red-White Valve Corp.
23. Stockham Valves and Fittings, Inc.
25. Tyco/Pentair LTD.
27. Victaulic Company.

2.4 BRONZE BALL VALVES

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange (Lug) Butterfly Valves:

1. Description:
b. CWP Rating: 150 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 or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. **Disc: Nylon 11 coated ductile iron.**

B. 175 CWP, Iron, Single-Flange (Lug) Butterfly Valves:

1. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 175 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 or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. **Disc: Nylon 11 coated ductile iron.**

C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and **Nylon 11 coated ductile Iron Disc**:

1. Description:
   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 or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. **Disc: Nylon 11 coated ductile iron.**

D. 250 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and **Nylon 11 coated ductile Iron Disc**:

1. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 250 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 or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. **Disc: Nylon 11 coated ductile iron.**
2.6 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valve:
   
   1. Description:
      
      b. CWP Rating: 200 psig.
      e. Ends: Threaded.
      f. Disc: Bronze, Type 1.

2.7 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:
   
   1. Description:
      
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 300 psig.
      c. Body Design: Horizontal flow.
      e. Ends: Threaded.
      f. Disc: Bronze.

2.8 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
   
   1. Description:
      
      a. Standard: MSS SP-71, Type 1.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. Body Design: Clear or full waterway.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Gasket: Asbestos free.

2.9 BRONZE GLOBE VALVES

A. Class 150, Bronze Globe Valves with Nonmetallic Disc:
   
   1. Description:
      
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 300 psig.

d. Ends: Threaded.

e. Stem: Bronze.

f. Disc: PTFE or TFE.

g. Packing: Teflon impregnated, asbestos free.

h. Handwheel: Malleable iron.

2.10 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

1. Description:

   a. Standard: MSS SP-78, Type II.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. Pattern: Regular or short.
   d. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
   e. Plug: Cast iron or bronze with sealant groove.

2.11 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to valve stems.

3. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve. Include zinc coating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do no proceed with installation until unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.
E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves as indicated, according to manufacturer’s written instructions.

B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above center of pipe.

F. Install valves in position to allow full stem movement.

G. Install chainwheels on operators for ball, butterfly globe and plug valves NPS 4 and larger and more than 96 inches above floor.

H. Extend the chainwheels for chains to 78 inches above finished floor.

I. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.
4. Install all check valves a minimum of five pipe diameters downstream of pump discharge or elbow to avoid flow turbulence. In extreme cases add flow straighteners as required to correct the turbulence.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. **Shutoff Service**: Ball or butterfly valves.
3. **Throttling Service except Steam**: Ball valves.
4. Pump-Discharge Check Valves:
OGDEN HIGH SCHOOL  
BOILER AND ROTC BUILDING HVAC REPLACEMENT  
VBFA #21323

a. **NPS 2 and Smaller:** Bronze swing check valves with **bronze** disc.
b. **NPS 2-1/2 and Larger:** Iron swing check valves with lever and weight or with spring or iron, **metal**-seat check valves.

5. **Drain Service (except Steam):** Two-Piece, Full Port Bronze Ball Valves with Bronze Trim. To be installed with NPS ¼ hose thread outlet and hose cap with chain.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 **HEATING-WATER VALVE SCHEDULE**

A. **Pipe NPS 2 and Smaller:**

1. **Bronze Valves:** May be provided with solder-joint ends instead of threaded ends.
3. **Ball Valves:**
   a. **Piece:** Two
   b. **Port:** Full.
   c. **Material/Trim:** **Bronze** with:
      1) **Bronze** trim.
4. **Bronze Swing Check Valves:**
   a. **Class 150**
   b. **Bronze** disc.

B. **Pipe NPS 2-1/2 and Larger:**

1. **Iron Valves, NPS 2-1/2 to NPS 4:** May be provided with threaded ends instead of flanged ends.
2. **Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12:**
   a. 200 CWP,
   b. **Seat:** **EPDM**.
   c. **Disc:** **Ductile-iron**.
3. **Iron Swing Check Valves:** **Class 125**, metal seats.

END OF SECTION 23 0523
SECTION 23 0529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.

B. Related Sections:

1. Division 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
3. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 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. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: **Signed and sealed by a qualified professional engineer.** Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of **carbon steel.**

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. **Anvil International.**
   b. **Cooper B-Line, Inc.; a division of Cooper Industries.**
   c. **ERICO/Michigan Hanger Co.; ERISTRUT Div.**
   d. **FNW/Ferguson Enterprises**
   e. **GS Metals Corp.**
   f. **Hilti, Inc.** Insert manufacturer's name.
   g. **Power-Strut Div. Tyco International.**
   h. **Thomas & Betts Corporation.**
   i. **Tolco Inc.**
   j. **Unistrut; an Atkore International company.**
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Metallic Coating:
   a. Electroplated zinc.

B. Non-MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International; a subsidiary of Mueller Water Products, Inc.
      b. Empire Industries, Inc.
      c. ERICO International Corporation.
      d. FNW/Ferguson Enterprises
      e. Haydon Corporation.
      f. NIBCO INC.
      g. PHD Manufacturing, Inc.
      h. PHS Industries, Inc.
   2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   7.
   8. Coating:
      a. Zinc.
   9.

2.4 THERMAL-HANGER SHIELD INSERTS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carpenter & Paterson, Inc.
   3. ERICO International Corporation.
   5. PHS Industries, Inc.
   6. Pipe Shields Inc.
   7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Hot Piping:
   1. Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

   2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 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 and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

K. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/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.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon-steel **pipe hangers and supports** and attachments for general service applications.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes **NPS 1/2 to NPS 30**.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes **NPS 4 to NPS 24**, requiring up to **4 inches** of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes **NPS 3/4 to NPS 36**, requiring clamp flexibility and up to **4 inches** of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes **NPS 1/2 to NPS 24** if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes **NPS 1/2 to NPS 4**, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes **NPS 3/4 to NPS 8**.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8**.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8**.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8**.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 8**.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 3**.
12. U-Bolts (MSS Type 24): For support of heavy pipes **NPS 1/2 to NPS 30**.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes **NPS 4 to NPS 36**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes **NPS 2-1/2 to NPS 36** if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes **NPS 1 to NPS 30**, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes **NPS 2-1/2 to NPS 24**, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes **NPS 2 to NPS 42** if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
P. Use **powder-actuated fasteners** instead of building attachments where required in concrete construction.

END OF SECTION 23 0529
SECTION 23 0548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

A. Provide engineered vibration isolation and restraint systems in accordance with the requirements of this section including design, engineering, materials, testing, inspections and reports.

B. Mechanical equipment with moving parts shall be mounted on or suspended from vibration isolators to reduce the transmission of vibration and mechanically transmitted sound to the building structure.

C. All mechanical equipment, piping and ductwork shall be restrained as required by Federal, State and Local building codes to preserve the integrity of nonstructural building components during seismic events to minimize hazards to occupants and reduce property damage.

1.3 SUMMARY

A. This Section includes the following:
1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
15. Restrained channel bracings.
16. Restrained cables.
17. Seismic-restraint accessories.
18. Mechanical anchor bolts.
19. Adhesive anchor bolts.
20. Vibration isolation equipment bases.
22. Certification of seismic restraint designs.
23. Installation supervision.
24. Design of attachment of housekeeping pads.
25. All components requiring IBC compliance and certification.
26. All inspection and test procedures for components requiring IBC compliance.
27. Restrained of all mechanical equipment, pipe and ductwork, within, on, or outdoors of the building and entry of services to the building, up to but not including, the utility connection, is part of this Specification.
28. Seismic certification of equipment

1.4 DEFINITIONS

C. ASCE: American Society of Civil Engineers
D. OSHPD: Office of Statewide Health Planning and Development for the State of California.
E. Ip: Importance Factor.
F. ESSENTIAL FACILITIES, (Occupancy Category IV, IBC-2018)

1. Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquakes.

G. LIFE SAFETY

1. All systems involved with fire protection, including sprinkler piping, jockey pumps, fire pumps, control panels, service water supply piping, water tanks, fire dampers, smoke exhaust systems and fire alarm panels.

2. All mechanical, electrical, plumbing or fire protection systems that support the operation of, or are connected to, emergency power equipment, including all lighting, generators, transfer switches and transformers.

3. All medical and life support systems.

4. Hospital heating systems and air conditioning systems for maintaining normal ambient temperature.

5. Automated supply, exhaust, fresh air and relief air systems on emergency control sequence, including air handlers, duct, dampers, etc., or manually-operated systems used for smoke evacuation, purge or fresh air relief by the fire department.

6. Heating systems in any facility with Occupancy Category IV, IBC-2009 where the ambient temperature can fall below 32 degrees Fahrenheit.

H. HIGH HAZARD
1. All gases or fluids that must be contained in a closed system which are flammable or combustible. Any gas that poses a health hazard if released into the environment and vented Fuel Cells.

1.5 REFERENCE CODES AND STANDARDS

A. Codes and Standards: The following shall apply and conform to good engineering practices unless otherwise directed by the Federal, State or Local authorities having jurisdiction.

1. IBC
2. ASCE 7
3. NFPA 13 (National Fire Protection Association)

B. The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.


1.6 ISOLATOR AND RESTRAINT MANUFACTURER’S RESPONSIBILITIES:

A. Provide project specific vibration isolation and seismic restraint design prepared by a registered design professional in the state were the project is being constructed, and manufacturer certifications that the components are seismically qualified.

1. Provide calculations to determine restraint loads resulting from seismic forces as required by IBC, Chapter 16 and ASCE 7, latest editions. Seismic calculations shall be certified by an engineer licensed in the state where the project is being constructed.

B. Provide installation instructions and shop drawings for all materials supplied under this section of the specifications.

1. Provide seismic restraint details with specific information relating to the materials, type, size, and locations of anchorages; materials used for bracing; attachment requirements of bracing to structure and component; and locations of transverse and longitudinal sway bracing and rod stiffeners.
2. Provide seismic bracing layout drawings indicating the location of all seismic restraints.
a. Each piece of rotating isolated equipment shall be tagged to clearly identify quantity and size of vibration isolators and seismic restraints.

C. Provide, in writing, the special inspection requirements for all Designated Seismic Systems as indicated in Chapter 17 of the IBC.

D. Provide training for installation, operation and maintenance of isolation and restraint systems.

1.7 PERFORMANCE REQUIREMENTS

A. Flood-Restraint Loading: Per the structural drawings and specifications.

B. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: Per the structural drawings and specifications.
   2. Assigned Occupancy Category as Defined in the IBC: Per the structural drawings and specifications.

   a. Component Importance Factor: 1.5.
      1) Life safety components required to function after an earthquake.
      2) Components containing hazardous or flammable materials in quantities that exceed the exempted amounts for an open system listed in Chapter 4.
      3) For structures with an Occupancy Category IV, components needed for continued operation of the facility or whose failure could impair the continued operation of the facility.
      4) Storage racks in occupancies open to the general public (e.g., warehouse retail stores).

   b. Component Importance Factor: 1.0.
      1) All other components

   c. Component Response Modification Factor: Per the structural drawings and specifications.

   d. Component Amplification Factor: Per the structural drawings and specifications.

3. Design Spectral Response Acceleration at Short Periods: Per the structural drawings and specifications.

4. Design Spectral Response Acceleration at 1-Second Period: Per the structural drawings and specifications.

1.8 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Submittals shall include catalog cut sheets and installation instructions for each type of anchor and seismic restraint used on equipment or components being isolated and/or restrained.
   2. Submittals for mountings and hangers incorporating springs shall include spring diameter and free height, rated load, rated deflection, and overload capacity for each vibration isolation device.
   3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.

b. Annotate to indicate application of each product submitted and compliance with requirements.

4. 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.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. “Basis for Design” report: Statement from the registered design professional that the design complies with the requirements of the ASCE 7-10 Chapter 13, IBC 2018 chapter 1908 and ACI 318. In addition, the basis for compliance must also be noted, as listed below:

   a. Project specific design documentation prepared and submitted by a registered design professional (ASCE 7, 13.2.1.1)
   b. Submittal of the manufacturer’s certification that the isolation equipment is seismically qualified by:
   c. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
   d. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
   e. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. Seismic restraint load ratings must be certified and substantiated by testing or calculations under direct control of a registered professional engineer. Copies of testing and calculations must be submitted as part of submittal documents. OSHPD pre-approved restraint systems are exempt from this requirement if their pre-approval is current and based upon the IBC 2009 (i.e. OPA-07 pre-approval numbers).

3. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

4. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

5. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

6. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

7. **Seismic**-Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.9 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

1. Submittal drawings and calculations must be stamped by a registered professional engineer in the State where the project is being constructed who is responsible for the seismic restraint design.

2. Calculations and restraint device submittal drawings shall specify anchor bolt type, embedment, concrete compressive strength, minimum spacing between anchors, and minimum distances of anchors from concrete edges. Concrete anchor locations shall not be near edges, stress joints, or an existing fracture. All bolts shall be ASTM A307 or better.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control test reports.
1.10 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.11 SEISMIC CERTIFICATION OF EQUIPMENT

A. Component Importance Factor. All plumbing and mechanical components shall be assigned a component importance factor. The component importance factor, \( I_p \), shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, \( I_p \), equal to 1.0.

C. For equipment or components where \( I_p = 1.0 \).

1. Submit manufacturer’s certification that the equipment is seismically qualified by:

   a. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
   b. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
   c. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. The equipment and components listed below are considered rugged and shall not require Special Seismic Certification:

   a. Valves (not in cast-iron housings, except for ductile cast iron).
b. Pneumatic operators.
c. Hydraulic operators.
d. Motors and motor operators.
e. Horizontal and vertical pumps (including vacuum pumps).
f. Air compressors
g. Refrigerators and freezers.
h. Elevator cabs.
i. Underground tanks.
j. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with Chapter 13, ASCE 7.

3. Rugged equipment and components in this section are for factory assembled discrete equipment and components only and do not apply to site assembled or field assembled equipment or equipment anchorage. The list is based in part on OSHPD Code Application Notice 2-1708A.5.

D. Special Certification requirements for Designated Seismic Systems (i.e. Ip = 1.5): Seismic Certificates of Compliance supplied by manufacturers shall be submitted for all components that are part of Designated Seismic Systems. In accordance with the ASCE 7, certification shall be via one of the following methods:

1. For active mechanical and electrical equipment that must remain operable following the design earthquake:
   a. Testing as detailed by part C.1.b above.
   b. Experience data as detailed by part C.1.c above.
   c. Equipment that is considered “rugged” per part C.2 above.

2. Components with hazardous contents shall be certified by the manufacturer as maintaining containment following the design earthquake by:
   a. Testing as detailed by part C.1.b above.
   b. Experience data as detailed by part C.1.c above.
   c. Engineering analysis utilizing dynamic characteristics and forces. Tanks (without vibration isolators) designed by a registered design professional in accordance with ASME Boiler and Pressure Vessel Code, and satisfying the force and displacement requirements of Sections 13.3.1 and 13.3.2 of ASCE 7 having an importance factor, Ip = 1.0 shall be considered to satisfy the Special Seismic Certification requirements on the basis of ASCE 7 Section 13.6.9.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Elastomeric Isolation Pads P1:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Ribbed pattern.
5. Load-bearing metal plates adhered to pads.

C. Double-Deflection, Elastomeric Isolation Mounts M1:

1. Mounting Plates:
   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded, or with threaded studs or bolts.
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

D. Restrained Elastomeric Isolation Mounts M2:

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

E. Spring Isolators S1: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
F. Restained Spring Isolators **S2**: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Baseplates shall limit floor load to 500 psig.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Restained Spring Isolators **S3**: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with **adjustable** snubbers to limit vertical movement.
   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric pad: For high frequency absorption at the base of the spring.

H. Elastomeric Hangers **H1**: 

1. Description: Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods
   a. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
   b. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.
I. Spring Hangers H2: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and Insert in Compression.
   a. 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.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   g. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop H3: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and insert in Compression and vertical limit stop.
   a. 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.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   g. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   h. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support R1:

1. Description: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene.
   a. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
   b. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.
L. Resilient Pipe Guides \textbf{R2}:

1. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.

   a. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

M. Horizontal Thrust Restraints \textbf{T1}: Modified specification S2 isolator.

1. Horizontal thrust restraints shall consist of a modified specification S2 spring mounting. Restraint springs shall have the same deflection as the isolator springs.
2. The assembly shall be preset at the factory and fine tuned in the field to allow for a maximum of 1/4" movement from stop to maximum thrust.
3. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure.
4. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit.

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Restrained Vibration Isolation Roof-Curb Rails: \textbf{RC1}:

C. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

D. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic forces.

E. Lower Support Assembly: The lower support assembly shall be a formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

F. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are
accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. **Restrained Spring Isolators**: Freestanding, steel, open-spring isolators with seismic and wind restraint.
   a. **Housing**: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
   b. **Outside Spring Diameter**: Not less than 80 percent of the compressed height of the spring at rated load.
   c. **Minimum Additional Travel**: 50 percent of the required deflection at rated load.
   d. **Lateral Stiffness**: More than 80 percent of rated vertical stiffness.
   e. **Overload Capacity**: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. **Snubber Bushings**: All-directional, elastomeric snubber bushings at least 1/4 inch-thick.

H. **Water Seal**: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

I. All roof curbs shall be at least 8-inches (MIN) above the roof membrane.

2.3 **VIBRATION ISOLATION EQUIPMENT BASES**

A. **Manufacturers**: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. **Steel Bases and Rails** **SB1**: Factory-fabricated, welded, structural-steel bases and rails.

1. **Design Requirements**: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.

2. **Structural Steel**: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. **Support Brackets**: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
C. **Inertia Base IB1:** Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. **Design Requirements:** Lowest possible mounting height with not less than [1-inch] 2-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.

2. **Structural Steel:** Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. **Support Brackets:** Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4. **Fabrication:** Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

### 2.4 SEISMIC-RESTRAINT DEVICES

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. **General Requirements for Restraint Components:** Rated strengths, features, and applications shall be as defined in reports by an **evaluation service member of ICC-ES**.

1. **Structural Safety Factor:** Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. **Snubbers:** Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. **Resilient Isolation Washers and Bushings:** Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

D. **Channel Support System:** MFMA-4, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
E. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Cables located in exterior or other wet locations such as wash-down areas shall be stainless steel.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

G. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

H. 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.

I. 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.

J. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

K. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

L. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

M. All post installed anchors utilized in the seismic design must be qualified for use in cracked concrete and approved for use with seismic loads.

N. Expansion anchors shall not be used for anchorage of equipment with motors rated over 10 HP with the exception of undercut expansion anchors. Spring or internally isolated equipment are exempt from this requirement.

O. All beam clamps utilized for vertical support must also incorporate retention straps.

P. All seismic brace arm anchorages to include concrete anchors, beam clamps, truss connections, etc., must be approved for use with seismic loads.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 4,000 psi or as specified by the project engineer. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.

C. Housekeeping pads shall have adequate space to mount equipment and seismic restraint devices.

D. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors and shall also be large enough and thick enough to ensure adequate edge distance and embedment depth for restraint anchor bolts to avoid housekeeping pad breakout failure. Refer seismic restraint manufacturer’s written instructions.

E. Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer’s written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer’s written instructions.
3.3 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES and per the seismic restraint manufacturer's design.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

C. Isolate all mechanical equipment 0.75 hp and over per the isolator and seismic restraint schedule and these specifications. Vibration isolators shall be selected in accordance with the equipment, pipe or duct weight distribution so as to produce reasonably uniform deflections

D. All isolation materials and seismic restraints shall be of the same vendor and shall be selected and certified using published or factory certified data

E. Installation of all vibration isolation materials, flexible connectors and supplemental equipment bases specified in this section shall be accomplished as per the manufacturer's written instructions with mountings adjusted to level equipment. Any variance or non-compliance with the manufacturer's instructions shall be reviewed and approved in writing by the manufacturer or corrected by the contractor in an approved manner.

F. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

G. Locate isolation hangers as near to the overhead support structure as possible.

H. No rigid connections between isolated components and the building structure shall be made that degrades the noise and vibration control system herein specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls. "Components" includes, but is not limited to, mechanical equipment, piping and ducts.

I. Coordinate work with other trades to avoid rigid contact with the building.

J. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
K. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor’s expense.

L. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor’s expense.

M. Use horizontal thrust restraints T1 to protect Air handling equipment and centrifugal fans against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight.

N. Isolated equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.

O. On completion of installation of all isolation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.

P. All floor mounted isolated equipment shall be protected with specification M1, M2, S1, S2 or S3 isolator.

Q. Horizontal Pipe Isolation: All HVAC pumped water, pumped condensate, glycol, and refrigerant piping size 1-1/4” and larger within mechanical rooms shall be isolated. Outside equipment rooms this piping shall be isolated for the greater of 50’ or 100 pipe diameters from rotating equipment. For the first three (3) support locations from externally isolated equipment provide specification H2 or H3 hangers or specification S1, S2 or S3 mounts with the same deflection as equipment isolators (max 2”). All other piping within the equipment rooms shall be isolated with the same specification isolators with a 3/4” minimum deflection. Steam piping size 1-1/4” and larger which is within an equipment room and connected to rotating equipment shall be isolated for three (3) support locations from the equipment. Provide specification H2 or H3 hangers, or specification S1 or S2 mounts with the same deflection as equipment isolators but a minimum of ¾”.

R. Install full line size flexible pipe connectors at the inlet and outlet of each pump, cooling tower, condenser, chiller, cooling connections and where shown on the drawings. All connectors shall be suitable for use at the temperature, pressure, and service encountered at the point of installation and operation. End fitting connectors shall conform to the pipefitting schedule. Control rods or protective braid must be used to limit elongation to 3/8”. Flexible connectors shall not be required for suspended in-line pumps.

S. All plumbing pumped water, piping size 1-1/4” and larger within mechanical rooms shall be isolated the same as HVAC piping above. Isolators are not required for any plumbing pumped water, pumped condensate, and steam piping outside of mechanical rooms unless listed in the isolation schedule.

T. Pipe Riser Isolation: The operating weight of all variable temperature vertical pipe risers 1-1/4” and larger, requiring isolation where specifically shown and detailed on riser drawings shall be fully supported by specification M1, M2 or R1 supports. S1, S2, S3, H2 or H3 steel spring deflection isolators with minimum 3/4-inch minimum shall be in those locations where added deflection is required due to pipe expansion and contraction. Spring deflection shall be a
minimum of 4 times the anticipated deflection change. Springs shall be selected to keep the riser in tension. Height saving brackets used with isolators having 2.5” deflection or greater shall be of the precompression type to limit exposed bolt length. Specification R1 riser supports shall be installed near the center point of the riser to anchor the riser when spring isolation is used. Specification R2 riser guides may be used in conjunction with spring isolators per design calculations. Pipe risers up through 16” shall be supported at intervals of every third floor of the building. Pipe risers 18” and over, every second floor. Wall sleeves for take-offs from riser shall be sized for insulation O.D. plus two times the anticipated movement to prevent binding. Horizontal take-offs and at upper and lower elbows shall be supported with spring isolators as required to accommodate anticipated movement. In addition to submittal data requirements previously outlined, riser diagrams and calculations shall be submitted for approval. Calculations must show anticipated expansion and contraction at each support point, initial and final loads on the building structure, and spring deflection changes. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist if installed per design proposed.

U. Where riser pipes pass through cored holes, core diameters shall be a maximum of 2” larger than pipe O.D. including insulation. Cored holes must be packed with resilient material or firestop as provided by other sections of this specification or local codes. Where seismic restraint is required specification isolator S3 shall support risers and provide longitudinal restraint at floors where thermal expansion is minimal and will not bind isolator restraints.

V. Duct Isolation: Isolate all duct work with a static pressure 2” W.C. and over in equipment rooms and to minimum of 50 feet from the fan or air handler. Use specification type H2 or H3 hangers or type S1 or S2 floor mounts.

3.5 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. On projects with Seismic Site Class A or B, seismic design or restraint is not required.

2. On projects with Seismic Design Category C: Components with an importance factor of 1.0 do not require seismic design or restraint.

3. 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.

4. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

5. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

6. Suspended Equipment: All suspended equipment that meets any of the following conditions requires seismic restraints as specified by the supplier:

a. Rigidly attached to pipe or duct that is 75 lbs. and greater,
b. Items greater than 20 lbs and distribution systems weighing more than 5 lbs/lineal foot, with an importance factor of 1.0 hung independently or with flexible connections.
c. Possibility of consequential damage.
d. For importance factors greater than 1.0 all suspended equipment requires seismic restraint regardless of the above notes.
e. Wall mounted equipment weighing more than 20 lbs.
f. Exemptions:
   1) Equipment weighing less than 20 lbs and distribution systems weighing less than 5 lbs/lineal foot, with an Ip = 1.0 and where flexible connections exist between the component and associated ductwork, piping or conduit.

7. Base Mounted Equipment: All base mounted equipment that meets any of the following conditions requires attachments and seismic restraints as specified by the supplier:
   a. Connections to or containing hazardous material,
   b. With an overturning moment.
   c. Weight greater than 400 lbs.
   d. Mounted on a stand 4 ft. or more from the floor
   e. Possibility of consequential damage.
   f. For importance factors greater than 1.0 all base mounted items require seismic restraints regardless of the above notes.
   g. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
   h. Exemptions:
      1) Floor or curb-mounted equipment weighing less than 400 lbs and not resiliently mounted, where the Importance Factor, Ip = 1.0, the components are mounted at 4 feet or less above a floor level, flexible connections between the components and associated duct work, piping and conduit are provided and there is no possibility of consequential damage.

8. Roof Mounted Equipment:
   a. To be installed on a structural frame, seismically rated roof curb, or structural curb frame mechanically connected to the structure. Items shall not be mounted onto sleepers or pads that are not mechanically and rigidly attached to the structure. Restraint must be adequate to resist both seismic and wind forces.
   b. Roof curbs shall be installed directly to building structural steel or concrete roof deck and not to top of steel deck or roofing material.
   c. Exemptions:
      1) Curb-mounted mushroom, exhaust and vent fans with curb area less than nine square feet are excluded.

9. Rigid Mounted Equipment:
   a. Anchor floor and wall mounted equipment to the structure as per the stamped seismic certifications / drawings.
b. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.

c. Suspended equipment shall be restrained using seismic cable restraints, or struts, and hanger rods as per the stamped seismic certifications / drawings.

10. Vibration Isolated Equipment:

a. Seismic control shall not compromise the performance of noise control, vibration isolation or fire stopping systems.

b. Equipment supported by vibration-isolation hangers shall be detailed and installed with approximately a 1/8” gap between the isolation hangers and the structure. Isolators at restraint locations must be fitted with uplift limit stops.

B. 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.

C. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

E. Installation and adjustment of all seismic restraints specified in this section shall be accomplished as per the manufacturer’s written instructions. Any deviation from the manufacturer’s instructions shall be reviewed and approved by the manufacturer.

F. Piping Restraints:

1. Comply with requirements in ASCE 7-10 Chapter 13.
2. Branch lines may not be used to brace main lines.
3. All piping requires restraint unless it meets any of the exemptions listed below.
4. Exemptions:

   a. All high deformability pipe 3” or less in diameter suspended by individual hanger rods where Ip = 1.0.
   b. High deformability pipe or conduit in Seismic Design Category C, 2” or less in diameter suspended by individual hanger rods where Ip = 1.5.
   c. High deformability pipe in Seismic Design Category D, E or F, 1” or less in diameter suspended by individual hanger rods where Ip = 1.5.
   d. All clevis supported pipe runs installed less than 12” from the top of the pipe to the underside of the support point and trapeze supported pipe suspended by hanger rods having a distance less than 12” in length from the underside of the pipe support to the support point of the structure.
   e. Piping systems, including their supports, designed and constructed in accordance with ASME B31.
   f. Piping systems, including their supports, designed and constructed in accordance with NFPA, provided they meet the force and displacement requirements of Section 13.3.1 and 13.3.2 (ASCE 7).
G. Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.

H. Install flexible piping connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

I. Where pipe sizes reduce below dimensions required for seismic, the final restraint shall be installed at the transition location.

J. Restraint Spacing For Piping: Sizes shown are maximum. Actual spacing determined by calculation.
   1. For non-ductile piping (e.g., cast iron, PVC) space transverse supports a maximum of 20’ o.c., and longitudinal supports a maximum of 40’ o.c.
   2. For piping with hazardous material inside (e.g., natural gas, medical gas) space Transverse supports a maximum of 20’ o.c., and longitudinal supports a maximum of 40’ o.c.
   3. For pipe risers, restrain the piping at floor penetrations using the same spacing requirements as above.
   4. For all other ductile piping see Table “A” below

K. Seismic Restraint of Ductwork: Seismically restrain per specific code requirements, all ductwork listed below (unless otherwise indicated on the drawings), using seismic cable restraints: (Ductwork not meeting criteria listed below is to be “Exempt”)
   1. Restrain rectangular ductwork with cross sectional area of 6 square feet or larger. Duct with and an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
   2. Restrain round ducts with diameters of 33” or larger. Duct with an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
   3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
   4. Duct must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze. Additional reinforcing is not required if duct sections are mechanically fastened together with frame bolts and positively fastened to the duct support suspension system.
   5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
   6. Walls, including gypsum board non-bearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
   7. If ducts are supported by angles, channels or struts, ducts shall be fastened to it at seismic brace locations in lieu of duct reinforcement.
   8. All ductwork weighing more than 17 lb/ft.
   9. Exemptions:
a. Duct runs supported at locations by two rods less than 12 inches in length from the structural support to the structural connection to the ductwork. This exemption does not apply to ducts with an importance factor of 1.5.

10. See Table “A” below for restraint spacing.

L. Exemptions do not apply for:

1. Life Safety or High Hazard Components
   a. Including gas, fire protection, medical gas, fuel oil and compressed air needed for the continued operation of the facility or whose failure could impair the facility’s continued operation, Occupancy Category IV, IBC-2009 as listed in Section 1.3 B regardless of governing code for HVAC, Plumbing, Electrical piping or equipment. (A partial list is illustrated.) High Hazard is additionally classified as any system handling flammable, combustible or toxic material. Typical systems not excluded are additionally listed below.

2. Piping
   a. Fuel oil, gasoline, natural gas, medical gas, steam, compressed air or any piping containing hazardous, flammable, combustible, toxic or corrosive materials. Fire protection standpipe, risers and mains. Fire Sprinkler Branch Lines must be ended.

3. Duct
   a. Smoke evacuation duct or fresh air make up connected to emergency system, emergency generator exhaust, boiler breeching or as used by the fire department on manual override.

4. Equipment
   a. Previously excluded non life safety duct mounted systems such as fans, variable air volume boxes, heat exchangers and humidifiers having a weight greater than 75 lbs require independent seismic bracing.

M. Spacing Chart For Suspended Components:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>On Center Transverse</th>
<th>On Center Longitudinal</th>
<th>Change Of Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Sizes</td>
<td>30 Feet</td>
<td>60 Feet</td>
<td>4 Feet</td>
</tr>
<tr>
<td>Pipe Threaded, Welded, Soldered Or Grooved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 16”</td>
<td>40 Feet</td>
<td>80 Feet</td>
<td>4 Feet</td>
</tr>
<tr>
<td>18” – 28”</td>
<td>30 Feet</td>
<td>60 Feet</td>
<td>4 Feet</td>
</tr>
<tr>
<td>30” – 40”</td>
<td>20 Feet</td>
<td>60 Feet</td>
<td>4 Feet</td>
</tr>
<tr>
<td>42” &amp; Larger</td>
<td>10 Feet</td>
<td>30 Feet</td>
<td>4 Feet</td>
</tr>
</tbody>
</table>
N. Roof mounted duct is to be installed on sleepers or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading factors shall be determined by the registered design professional.

O. Where duct sizes reduce below dimensions required for seismic restraint the final restraint shall be installed at the transition location.

P. Install cables so they do not bend across edges of adjacent equipment or building structure.

Q. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

R. 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.

S. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

T. Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.

U. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.
3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

1. A representative of the vibration isolation system manufacturer shall review the project installation and provide documentation indicating conformance to vibration isolation design intent.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

1. The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer’s representative’s final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

3.8 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

1. Adjust active height of spring isolators.

C. 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.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>A' CRITICAL (35'-50' SPAN)</th>
<th>B' UPPER STORY (20'-35' SPAN)</th>
<th>C GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION</td>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>BASE TYPE</td>
</tr>
<tr>
<td>AIR HANDLING UNITS FLOOR MOUNTED</td>
<td>AIR HANDLING UNITS SUSPENDED</td>
<td>HIGH PRESSURE FAN SECTIONS</td>
<td>CENTRIFUGAL FANS</td>
</tr>
<tr>
<td>UP TO 15 HP</td>
<td>S3</td>
<td>1.5</td>
<td>S3</td>
</tr>
<tr>
<td>20 HP &amp; OVER</td>
<td>S3</td>
<td>2.5</td>
<td>SB1</td>
</tr>
<tr>
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<td>H3</td>
<td>1.75</td>
<td>H3</td>
</tr>
<tr>
<td></td>
<td>H3</td>
<td>2.5</td>
<td>SB1</td>
</tr>
<tr>
<td></td>
<td>S1</td>
<td>2.5</td>
<td>IB1</td>
</tr>
<tr>
<td></td>
<td>S1</td>
<td>3.5</td>
<td>IB1</td>
</tr>
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</table>

VIBRATION AND SEISMIC CONTROLS FOR HVAC 230548 - 25
OGDEN HIGH SCHOOL
BOILER AND ROTC BUILDING HVAC REPLACEMENT

<table>
<thead>
<tr>
<th>60 HP &amp; OVER</th>
<th>S1</th>
<th>3.5</th>
<th>IB1</th>
<th>S1</th>
<th>2.5</th>
<th>IB1</th>
<th>S3</th>
<th>1.5</th>
<th>SB1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL. I &amp; II FD’S W/D. &amp; OVER/ALL CL. III FANS</td>
<td>UPTO100HP</td>
<td>S1</td>
<td>2.5</td>
<td>IB1</td>
<td>S3</td>
<td>1.5</td>
<td>IB1</td>
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<td>0.75</td>
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<tr>
<td>20-90 HP</td>
<td>S1</td>
<td>2.5</td>
<td>IB1</td>
<td>S1</td>
<td>2.5</td>
<td>IB1</td>
<td>S3</td>
<td>1.5</td>
<td>IB1</td>
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<td>3.5</td>
<td>IB1</td>
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<td>S3</td>
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<th>1.5</th>
<th>SB1</th>
<th>S3</th>
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<td>S3</td>
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<td>IB1</td>
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<tr>
<td>SUSPENDED</td>
<td>UPTO 15 HP</td>
<td>H3</td>
<td>1.75</td>
<td>SB1</td>
<td>H3</td>
<td>1</td>
<td>H3</td>
<td>1</td>
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<tr>
<td>20 HP &amp; OVER</td>
<td>H3</td>
<td>2.5</td>
<td>SB1</td>
<td>H3</td>
<td>1.75</td>
<td>SB1</td>
<td>H3</td>
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<th>SB1</th>
<th>S3</th>
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<td>H3</td>
<td>1.75</td>
<td>SB1</td>
<td>H3</td>
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<th>0.75</th>
<th>IB1</th>
<th>S3</th>
<th>0.75</th>
<th>IB1</th>
<th>SRVD</th>
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<td>1.75</td>
<td>IB1</td>
<td>H3</td>
<td>1.75</td>
<td>IB1</td>
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<th>1.5</th>
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<td>H3</td>
<td>1.75</td>
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<th>RECIPROCATING COMPRESSORS</th>
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<th>IB1</th>
<th>S3</th>
<th>1.5</th>
<th>IB1</th>
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<td>RECIPROCATING COND. UNITS &amp; CHILLERS</td>
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<td>ABSORPTION MACHINES</td>
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<td>1.5</td>
<td>IB1</td>
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<th>TANK TYPE (HORIZONTAL TANK)</th>
<th>S1</th>
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<th>IB1</th>
<th>S3</th>
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<th>COOLING TOWERS &amp; CLOSED CIRCUIT COOLERS</th>
<th>UPTO 1500 TONS</th>
<th>S3</th>
<th>2.5</th>
<th>IB1</th>
<th>S3</th>
<th>1.5</th>
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<td>OVER 500 TONS</td>
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<th>ROOF TOP AIR CONDITIONING UNITS</th>
<th>REQUIRING WEATHER SEAL</th>
<th>UPTO 5000 CFM (12 TON)</th>
<th>S1</th>
<th>1.5</th>
<th>RC1</th>
<th>S1</th>
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<td>OVER 5000 CFM (12 TON)</td>
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<td>RC1</td>
<td>S3</td>
<td>1.5</td>
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<tr>
<td>OTHER TYPES</td>
<td>UPTO 25 TONS</td>
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<td>1.5</td>
<td>IB1</td>
<td>S3</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OVER 25 TONS</td>
<td>S3</td>
<td>2.5</td>
<td>IB1</td>
<td>S3</td>
<td>1.5</td>
<td></td>
<td></td>
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| BOILER (PACKAGE TYPE) | ALL SIZES | S3 | 1.5 | IB1 | S3 | 1.5 | IB1 | S3 | 0.75 |

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<tr>
<th>ENGINE DRIVEN GENERATORS</th>
<th>UPTO 60 HP</th>
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<th>IB1</th>
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<td>IB1</td>
<td>S3</td>
<td>0.75</td>
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NOTES:
1) Thrust restraints required on all high-pressure fan section, suspended axial-flow fans and on floor-mounted axial fans operating at 3.0” S.P. or greater.

END OF SECTION 23 0548
SECTION 23 0550 - OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All pertinent sections of Division 21, 22, & 23 Mechanical General Requirements, are part of the work of this Section. Division 1 is part of this and all other sections of these specifications.

1. Testing and Balancing is specified in section 230594.
2. Training and Instructions to Owner’s Representative is specified in section 230100.

1.2 SCOPE OF WORK

A. Submission of Operating and Maintenance Manuals complete with Balancing reports. (Coordinate with Division 1).

B. Coordination of work required for system commissioning.

C. Provide a hard copy and an electronic copy on CD of the O and M manual fully searchable in PDF format.

1.3 SUBMITTALS

A. Submit product data in accordance with Division 1 and Section 230100. Submit the following:

2. Hard copy and an electronic copy on CD of the O and M manual fully searchable in PDF format. Both the hard copy and the electronic copy are to be fully indexed. The electronic copy shall also have a linked index.

PART 2 - PRODUCTS

2.1 O & M MANUALS

A. The operating and maintenance manuals shall be as follows:

1. Binders shall be red buckram with easy-view metal for size 8-1/2 x 11-inch sheets, with capacity expandable from 2 inches to 3-1/2 inches as required for the project. Construction shall be rivet-through with library corners. No. 12 backbone and lining shall be the same material as the cover. The front cover and backbone shall be foil-stamped in white as follows: (coordinate with Division 01)

OPERATING AND MAINTENANCE MANUAL
PART 3 - EXECUTION

3.1 OPERATING AND MAINTENANCE MANUALS:

A. Work under this section shall be performed in concert with the contractor performing the system testing and balancing. Six (6) copies of the manuals shall be furnished to the Architect for distribution to the owner.

B. The "Start-Up and Operation" section is one of the most important in the manual. Information in this section shall be complete and accurately written and shall be verified with the actual equipment on the job, such as switches, starters, relays, automatic controls, etc. A step-by-step start-up procedure shall be described.

C. The manuals shall include air and water-balancing reports, system commissioning procedures, start-up tests and reports, equipment and system performance test reports, warranties, and certificates of training given to the owner’s representatives.

An index sheet typed on AICO Gold-Line indexes shall be provided in the front of the binder. The manual shall be include the following:

SYSTEM DESCRIPTIONS

START-UP PROCEDURE AND OPERATION OF SYSTEM

MAINTENANCE AND LUBRICATION TABLE

OPERATION AND MAINTENANCE BULLETINS

AUTOMATIC TEMPERATURE CONTROL DESCRIPTION OF OPERATION, INTERLOCK AND CONTROL DIAGRAMS, AND CONTROL PANELS.

AIR AND WATER SYSTEM BALANCING REPORTS

EQUIPMENT WARRANTIES AND TRAINING CERTIFICATES
SYSTEM COMMISSIONING REPORTS

EQUIPMENT START-UP CERTIFICATES

END OF SECTION 23 0550
SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:
   1. Equipment labels.
   2. Danger, Warning and Caution signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Stencils.
   6. Valve tags.
   7. Danger tags.
   8. Warning tags.

1.3 ACTION SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.
2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Minimum Thickness, predrilled or stamped holes for attachment hardware:
      a. Brass, 0.032-inch.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   4. Fasteners: Stainless-steel;
      a. Rivets or self-tapping screws
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, and having predrilled holes for attachment hardware, 1/16 inch thick.
   2. Letter Color:
      a. Black.
   3. Background Color:
      a. White.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Fasteners: Stainless-steel;
      a. Rivets or self-tapping screws
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
2.2 DANGER, WARNING AND CAUTION SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, having predrilled holes for attachment hardware; 1/16 inch thick.

Danger signs, colors:
1. Letter Color:
   a. White.
2. Background Color:
   a. Red.

B. Warning signs, colors:
1. Letter Color:
   a. Black.
2. Background Color:
   a. Orange.

C. Caution signs, colors:
1. Letter Color:
   a. Black
2. Background Color:
   a. Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel;
   1. Rivets or self-tapping screws
   2. Rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

   A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, having predrilled holes for attachment hardware; 1/16 inch thick.

   B. Letter Color:
      1. White.

   C. Background Color:
      1. 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-fourths the size of principal lettering.

   G. Fasteners: Stainless-steel;
      1. Rivets or self-tapping screws

   H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

   I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

      1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
      2. Lettering Size: At least 1-1/2 inches high.

2.5 STENCILS

   A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

      1. Stencil Material:
         a. Aluminum.
      2. Stencil Paint:
         a. Exterior, gloss, alkyd enamel black unless otherwise indicated.
b. Paint may be in pressurized spray-can form.
3. Identification Paint:
a. Exterior, **alkyd enamel** in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material, predrilled or stamped holes for attachment hardware, minimum thickness:
   a. **Brass, 0.032-inch**
2. Fasteners: Brass;
   a. **Wire-link or beaded chain; or S-hook**

B. Valve Schedules:

1. For each piping system, on **8-1/2-by-11-inch** bond paper, tabulate;
   a. Valve number.
   b. Piping system.
   c. System abbreviation (as shown on valve tag).
   d. Location of valve (room or space).
   e. Normal-operating position (open, closed, or modulating).
   f. Variations for identification.
   g. Mark valves for emergency shutoff and similar special uses.

2. Valve-tag schedule:
   a. Shall be included in operation and maintenance data.

2.7 DANGER TAGS

A. Danger Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size:
   a. **3 by 5-1/4 inches minimum**
2. Fasteners:
   a. **Brass grommet and wire.**
3. Nomenclature: Large-size primary caption such as "DANGER," and "DO NOT OPERATE."

2.8 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size:
a. 3 by 5-1/4 inches minimum
2. Fasteners:
   a. Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as “WARNING” and "DO NOT OPERATE."

2.9 CAUTION TAGS

A. Caution Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size:
   a. 3 by 5-1/4 inches minimum
2. Fasteners:
   a. Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "CAUTION," and "DO NOT OPERATE."

2.10 CEILING GRID

A. Provide valve identification for all HVAC valves located above the ceiling on the ceiling grid below the valve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Stenciled Pipe Label Option:
1. Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option.

2. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.
   b. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

D. Pipe Label Color Schedule: (See Drawing Schedules)

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION (See Drawing Schedules.)

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.
END OF SECTION 23 0553
SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.

2. Balancing Hydronic Piping Systems:
   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.
   c. Primary-secondary hydronic systems.

3. Various HVAC Equipment.
   a. Motors.
   b. Condensing Units.
   c. Boilers.
   d. Heat Transfer Coils.


1.3 DEFINITIONS


C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.
1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within the following number of days of the Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article;
   1. 30 days.

B. Certified TAB reports.

C. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB and shall be the same as the TAB Contractor.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician and shall be the same as the TAB Contractor.

B. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by:
   1. Architect.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
B. Perform TAB after leakage and pressure tests on the following distribution systems have been satisfactorily completed:
   1. Air.
   2. Water.
   3. Air and water.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS
   A. Subject to compliance with requirements, engage one of the following:
      1. Bonneville Test and Balance
      2. BTC Service.
      3. Certified Test & Balance.
      5. RS Analysis.
      6. Test & Balance Inc.
      7. Payson Sheetmetal.
      8. QT&B Inc.

3.2 EXAMINATION
   A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   B. Examine systems for installed 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 accessible.
   C. Examine the approved submittals for HVAC systems and equipment.
   D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
   E. Examine:
      1. Ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in:
         a. Section 233113 "Metal Ducts"
      2. Verify ceiling plenums and underfloor air plenums used for supply, return or relief air are properly separated from adjacent areas.
      3. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
   F. Examine equipment performance data including fan and pump curves.
1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in this section and:
   1. AABC's "National Standards for Total System Balance"

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. 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).

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. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.
K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from one of the following entities for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance:

   a. Architect.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems 'as-built' piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open all manual valves for maximum flow.
   2. Check liquid level in expansion tank.
   3. Check makeup water-station pressure gage for adequate pressure for highest vent.
   4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
   5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
   6. Set system controls so automatic valves are wide open to heat exchangers.
   7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
   8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from the following entity and comply with requirements in Section 232123 "Hydronic Pumps."
   1) [Architect].

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

   a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

   1. Determine the balancing station with the highest percentage over indicated flow.

   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

   3. Record settings and mark balancing devices.
H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.13 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.
3.14 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
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. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.15 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.

3.16 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems'
balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare progress reports on the following interval to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors;

1. Weekly.

3.17 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.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.

E. Make-up Air Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches, and bore.
   i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   j. Number, make, and size of belts.
   k. Number, type, and size of filters.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
OGDEN HIGH SCHOOL
BOILER AND ROTC BUILDING HVAC REPLACEMENT

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Heating-coil static-pressure differential in inches wg.
g. Outdoor airflow in cfm.
h. Outdoor-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Entering-air, wet- and dry-bulb temperatures in deg F.
f. Leaving-air, wet- and dry-bulb temperatures in deg F.
g. Water flow rate in gpm.
h. Water pressure differential in feet of head or psig.
i. Entering-water temperature in deg F.
j. Leaving-water temperature in deg F.
k. Refrigerant expansion valve and refrigerant types.
l. Refrigerant suction pressure in psig.
m. Refrigerant suction temperature in deg F.

G. Gas Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
2. Test Data (Indicated and Actual Values):
   a. Total air flow rate in cfm.
   b. Entering-air temperature in deg F.
   c. Leaving-air temperature in deg F.
   d. Air temperature differential in deg F.
   e. Entering-air static pressure in inches wg.
   f. Leaving-air static pressure in inches wg.
   g. Air static-pressure differential in inches wg.
   h. Low-fire fuel input in Btu/h.
   i. High-fire fuel input in Btu/h.
   j. Manifold pressure in psig.
   k. High-temperature-limit setting in deg F.
   l. Operating set point in Btu/h.
   m. Motor voltage at each connection.
   n. Motor amperage for each phase.
   o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
OGDEN HIGH SCHOOL
BOILER AND ROTC BUILDING HVAC REPLACEMENT

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated air flow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual air flow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Apparatus used for test.
   d. Area served.
   e. Make.
   f. Number from system diagram.
   g. Type and model number.
   h. Size.
   i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary air flow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final air flow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in deg F.

K. System-Coil Reports: For of fan coil terminal units, include the following:

1. Unit Data:
OGDEN HIGH SCHOOL  
BOILER AND ROTC BUILDING HVAC REPLACEMENT

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.
M. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.18 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
   a. Measure airflow of at least 10% percent of air outlets.
   b. Measure water flow of at least 5% percent of terminals.
   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d. Verify that balancing devices are marked with final balance position.
   e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by:
   a. Architect.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of:
   a. Architect.
3. The following entity shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day:
   a. Architect.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 0593
SECTION 23 0719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includesinsulating the following HVAC piping systems:

1. Condensate drain piping.
2. Heating hot-water piping.
3. Refrigerant suction and hot-gas piping.

1.3 DEFINITIONS:

A. Refer to Section 230500 “Common Work Results for HVAC”.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.7 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.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.9 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
PART 2 - PRODUCTS

2.1 INSULATION MATERIALS


B. Insulation for below-ambient service requires a vapor-barrier.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. 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.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. Calcium Silicate:

1. Products: Subject to compliance with requirements, provide the following:
   a. Industrial Insulation Group (IIG); Thermo-12 Gold.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553,

1. Type II and ASTM C 1290, Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2. Products: Subject to compliance with requirements, provide one of the following:
J. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Micro-Lok.
      b. Knauf Insulation; 1000-Degree Pipe Insulation.
      c. Manson Insulation Inc.; Alley-K.
      d. Owens Corning; Fiberglas Pipe Insulation.
      e. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A:
         1) with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied:
   1. ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/ft³ or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; CrimpWrap.
      b. Johns Manville; MicroFlex.
      c. Knauf Insulation; Pipe and Tank Insulation.
      d. Manson Insulation Inc.; AK Flex.
      e. Owens Corning; Fiberglas Pipe and Tank Insulation.

L. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.2 INSULATING CEMENTS

   1. Products: Subject to compliance with requirements, provide the following:
      a. Ramco Insulation, Inc.; Super-Stik.

   1. Products: Subject to compliance with requirements, provide the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.
2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
   
   1. Products: Subject to compliance with requirements, provide one of the following:
      
      b. Eagle Bridges - Marathon Industries; 290.
      d. Mon-Eco Industries, Inc.; 22-30.
      e. Vimasco Corporation; 760.

   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   
   1. Products: Subject to compliance with requirements, provide one of the following:
      
      a. Aeroflex USA, Inc.; Aerosel.
      b. Armacell LLC; Armaflex 520 Adhesive.
      d. K-Flex USA; R-373 Contact Adhesive.

   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   
   1. Products: Subject to compliance with requirements, provide one of the following:
      
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.

   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Corning Corporation; 739, Dow Silicone.
   d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
b. Eagle Bridges - Marathon Industries; 570.

2. Water-Vapor Permeance: ASTM F 1249, \textbf{0.05 perm} at \textbf{30-mil} dry film thickness.
3. Service Temperature Range: \textbf{Minus 50 to plus 220 deg F}.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 550.
      e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, \textbf{1.8 perms} at \textbf{0.0625-inch} dry film thickness.
3. Service Temperature Range: \textbf{Minus 20 to plus 180 deg F}.
4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide the following:

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: \textbf{Minus 40 to plus 250 deg F}.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: Color-code jackets based on system:
   a. White

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, **provide one of the following**:
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

   a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications:
      1) **1-mil**- thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications:
      1) **3-mil**- thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 370 White PVC tape.
      b. Compac Corporation; 130.
      c. Venture Tape; 1506 CW NS.

   2. Width: 2 inches.
   3. Thickness: 6 mils.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch in width.

2.9 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
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.
3. 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.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at a. 2 inches o.c.
      b. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.
3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.

2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.

3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

2. Install insulation to flanges as specified for flange insulation application.

3. Finish valve and specialty insulation same as pipe insulation.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches** o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least \textbf{1 inch}, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.9 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.
3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 Insulation shall have a k value that meets the minimum requirements of the latest International Energy Conservation Code (IECC).

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Flexible Elastomeric:
      1) 1/2 inch thick
   b. Mineral-Fiber, Prefomed Pipe Insulation, Type I:
      1) 1/2 inch thick

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 1 1/2 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Prefomed Pipe, Type I:
      1) 1-1/2 inch thick

2. Greater than NPS 1-1/2 inch: Insulation shall be the following:
   a. Mineral-Fiber, Prefomed Pipe, Type I or Pipe and Tank Insulation:
      1) 2 inches thick

3. Insulation for runouts not exceeding 48 inches in length for connection to equipment shall be the following:
   a. Mineral-Fiber, Prefomed Pipe, Type I: 1 inch thick.

C. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 1 inch thick.
3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.

D. Piping, Exposed:
   1. PVC:
      a. White: 30 mils thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.

D. Piping, Exposed:
   1. Aluminum, Stucco Embossed: 0.016 inch thick.

END OF SECTION 23 0719
SECTION 23 0900 - AUTOMATIC TEMPERATURE CONTROL SYSTEM

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. The General Condition, Supplementary General Conditions, alternates and addenda, applicable drawings, and the technical specifications, shall all apply to all work under this division.

1.2 SYSTEM DESCRIPTION

A. New control work shall be an extension of the existing District wide Schneider Electric by Utah Yamas Controls.

B. Extend existing control to include control and graphics for new Boilers, Pumps, VRF Systems, Make-up Air Units, hot water valves and thermostats, and controls per sequence in 23 0000 Automatic Temperature Control Sequences.

1.3 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure the Work will be carried out in an orderly fashion. It shall be the responsibility of the ATC Contractor to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct, and conduit runs, outlets and fixtures, air diffusers, and structural and architectural features. It is the responsibility of other trade work contractors to correspond with ATC contractors with schedule of installation of equipment involving section 23 0900 to ensure adequate timing to coordinate installation.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. The following is a list of approved component manufacturer’s:

1. Controllers –

   a. Schneider Electric,

2.2 APPROVED CONTRACTORS AND EQUIPMENT SUPPLIERS

A. Manufacturers: All components and controllers shall be manufactured by Schneider Electric.

1. Direct Digital Control Systems and Approved Installing Contractors:
PART 3 - SEQUENCE OF OPERATION

3.1 HEATING WATER SYSTEM

A. The main hot water heating pumps are controlled through the existing DDC controls and run per existing sequence of operation.

B. There are three new boilers. Each boiler has an isolation valve which is open when the boiler is on and closed when the boiler is off. The boilers shall alternate lead/lag weekly. If the main boiler fails, an alarm shall be generated and the lag boiler shall start. The sequence for starting each boiler shall be as follows: the boiler isolation valve shall open, when proven open the boiler circulation pump shall start; after starting the pump, after proof of the combustion air the boiler shall be enabled. The boiler circulation pump shall have a time-delay feature added through the DDC system such that when the boiler is disabled, the isolation valve shall remain open and the pump shall remain on for five minutes. (adj.)

C. Provide interlocks with the boiler alarm system to alarm the DDC system if boiler shuts down due to flame failure, etc. or if boiler does not fire when commanded to do so.

D. Provide analog temperature sensors in immersion wells in the hot water supply piping of each boiler as well as the main supply and return water lines leaving the boiler room.

E. The boilers supply temperature setpoint shall be reset based on the following schedule

<table>
<thead>
<tr>
<th>OA TEMP</th>
<th>SUPPLY TEMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>150</td>
</tr>
<tr>
<td>10</td>
<td>180</td>
</tr>
</tbody>
</table>

3.2 EMERGENCY SHUTDOWN SWITCHES (Boilers & Water Heaters)

A. A remote mushroom type, single acting, manually reset, shutdown switch shall be located just inside the boiler room door and marked for easy identification. A pilot light shall illuminate whenever the push button is pressed. If there is more than one door to the boiler room, there should be a switch located at each door.

B. The emergency shutdown switch(es) when activated must disconnect all power to the boiler burner and all hot water heater controls. A visual alarm indicator of a different color than the building fire alarm indicators shall be activated when the boilers are shutdown.

3.3 VRF SYSTEMS SERVING ROTC BUILDING AND FIRST AND SECOND FLOORS

A. The ROTC Building served by VRF (variable refrigerant flow) systems.
B. The control system shall provide a BacNet interface between the VRF system and the building automation system.

C. The control system shall control occupancy command and the space setpoints of the spaces served by the VRF system. Initial set points shall be 70 F heating and 74 F cooling. Night set back shall be coordinated and operated per the VRF manufacturers recommendations.

D. Ventilation air is provided by MAU-1 and MAU-2 which shall be enabled anytime any VRF zone is in occupied mode.

3.4 DEDICATED OUTDOOR-AIR UNITS MAU-1 AND MAU-2

A. The makeup air units shall come with factory-installed controls for connection to the DDC controller furnished by the ATC contractor. Each makeup air unit will consist of a supply fan, a hot water heating coil, filters, and outdoor air damper.

B. Each makeup air unit shall be enabled by the DDC control system.

C. In occupied mode the supply fan shall run continuous subject to safeties such as freezestat, building fire alarm, etc.

D. In unoccupied mode the supply fan shall be off.

E. If the supply fan should be off for any reason, the outside air damper should close. A manual reset averaging style low limit freeze stat located downstream of the heating coil shall shut down the fan and alarm the DDC system if discharge air temperature drops below 38 deg F.

F. OCCUPIED mode:

1. The DDC controls shall modulate the heating valve to maintain supply air temperature set point.

2. An averaging style air temperature sensor shall be located in the discharge air, acting through the DDC controls shall provide a low limit discharge air control of 50 deg F for the make-up air unit.

3.5 BOILER ROOM UNIT HEATER CONTROL

AUTOMATIC TEMPERATURE CONTROL SYSTEM
A room temperature sensor shall cycle the unit heater fan and valve to maintain desired boiler room space temperature. The unit heater fan shall not be controlled by an aqua-stat.

END OF SECTION 23 0900
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. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   4. Valves.
   5. Pressure regulators.

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 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 SUBMITTALS
A. Product Data: For each type of the following:
   1. Piping specialties.
   2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   3. Pressure regulators. Indicate pressure ratings and capacities.
   4. Dielectric fittings.
   5. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple
pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.

C. Operation and Maintenance Data:

1.5 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.

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.

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:
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
   1. Copper-alloy convenience outlet and matching plug connector.
   2. Nitrile seals.
   3. Hand operated with automatic shutoff when disconnected.
   4. For indoor or outdoor applications.
   5. Adjustable, retractable restraining cable.

2.3 JOINING MATERIALS
   A. Joint Compound and Tape: Suitable for natural gas.

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.
      3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
      5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
      6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
   B. Bronze Plug Valves: MSS SP-78.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Lee Brass Company.
      5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. 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 and smaller; flanged for regulators NPS 2-1/2 and larger.


1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   b. Invensys.
   c. Maxitrol Company.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
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.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

2.6 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Central Plastics Company.
e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
f. Wilkins; Zurn Plumbing Products Group.

3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.7 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

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 the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. 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 service regulators, 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 and 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 automatic or electrically operated valve.
U. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install anode for metallic valves in underground PE piping.

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. Welded Joints:

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.

D. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.6 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.7 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. 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.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

   1. Test, inspect, and purge natural gas according to the International Fuel Gas Code 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.

3.10 INDOOR PIPING SCHEDULE

A. Aboveground, piping NPS 2 and smaller shall be the following:

   1. Steel pipe with wrought-steel fittings and welded or threaded joints.
3.11 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
   1. Bronze plug valve.

END OF SECTION 23 1123
SECTION 23 2113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Condensate-drain piping.
3. Air-vent piping.
4. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Steel pipe and fittings.
2. Copper pipe, tubing and fittings.
3. Dielectric fittings.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.
C. Welding certificates.

D. Field quality-control reports: Written reports as specified in Part 3 of this section including:
   1. Test procedures used.
   2. Test results showing compliance with specified requirements.
   3. Failed test results with corrective action taken to achieve compliance with specified requirements.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

D. Coordinate pipe fitting pressure classes with products specified in related sections.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.
2.1 COPPER TUBE AND FITTINGS

A. **Drawn-Temper Copper Tubing**: ASTM B 88, Type L.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.


D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

2. End Connections: Butt welding.
3. Facings: Raised face.


I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless otherwise indicated.
a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   c. Capitol Manufacturing Company.
   d. Central Plastics Company.
   e. Elster Perfection.
   f. Grinnell Mechanical Products.
   g. Mateo-Norca.
   h. Pipeline Seal and Insulator, Inc.
   i. Precision Plumbing Products, Inc.
   j. Victaulic Company.
   k. Watts Regulator Co.
   l. Zurn Industries, LLC.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. End Connections: Threaded, or flanged.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. Dielectric Nipples or Waterways: Electroplated steel with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller shall be [any of] the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40, Grade B, Type 96 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be [any of] the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Condensate-drain piping shall be [any of] the following:

1. Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

E. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

F. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. PRE-WORK / PRE-REQUISITES

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

2. The Contractor shall study the architectural, structural, mechanical, electrical and other drawings to eliminate conflict of piping with other structure lighting or other services.

B. CONDITION

1. All installed pipelines shall be free from dents, scars, and burrs, with ends reamed smooth.
2. All piping shall be clean and free from acids and loose dirt when installed and shall be kept clean during the completion of the installation.

3. Install piping free of sags and bends.

4. All installed pipelines shall remain straight against strains tending to cause distortion during system operation. The contractor shall make proper allowance for pipeline expansion and contraction so that no unsightly distortion, noise, damage or improper operation results therefrom.

C. SELECTION

1. Select system components with pressure rating equal to or greater than system operating pressure.

2. No street type fittings shall be used.

3. No short nipples shall be used except at drain valves.

4. Plugs of rags, wool, cotton, waste, or similar materials may not be used for plugging.

D. ROUTING/ARRANGEMENT

1. Piping installations shall be neatly organized.

2. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

3. Install groups of pipes parallel to each other.

4. Install piping spaced to permit application of insulation.

5. Install piping parallel and spaced to permit the servicing of valves.

6. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls or axis of the building.

7. Diagonal runs are prohibited unless specifically indicated otherwise.

8. Install fittings for all changes in direction.

9. No piping shall be run above any electrical panels, electrical equipment or access clearances for electrical for electrical panels or equipment. No piping shall be allowed to run through any electrical rooms.

10. Piping shall be arranged, placed and installed to facilitate equipment maintenance and shall be so arranged to not interfere with the installation of the air-conditioning equipment, ducts, or the removal of other equipment or devices. All specialties shall be so placed to permit easy operation and access.

11. All piping shall be so installed to insure noiseless circulation.
12. Install fittings for all branch connections.

13. Unless otherwise indicated, install branch connections to mains using tee fittings or forged steel branch fittings in main pipe, with the branch connected to the bottom of the main pipe.

14. For up-feed risers, connect the branch to the top of the main pipe.

15. Forged branch fittings shall be installed per the manufacturer's recommendations.

E. ACCESS / ARRANGEMENT

1. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. All piping shall be so arranged to not block access to manholes, access openings, etc.

2. Install piping at indicated slopes. If not indicated, install piping at a uniform grade of 0.2 percent where possible, upward in direction of flow. Traps are to be avoided where-ever possible.

3. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

4. When insulated pipes are supported by a roller hanger they shall be protected from damage by suitable pipe covering protection saddles. Saddles shall support pipe on roller and shall be packed with insulation.

5. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

6. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, at each coil on all sides of automatic valves where valves do not have union connections, elsewhere as indicated, and wherever necessary to prevent undue difficulty in making repairs or replacement. Unions are not required at flanged connections.

7. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated. Install flanges on valves, apparatus, and equipment having 2 1/2 inch NPS and larger connections. Flanges or unions as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment.

8. Install shutoff valve immediately upstream of each dielectric fitting. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.


10. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
11. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

12. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

13. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS ¼) nipple and ball valve in blow-down connection of strainers NPS 2) and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2).

14. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration-producing equipment.

15. Polypropylene pipe in or passing through plenums must be fire wrapped or installed in a metal conduit.

F. DRAINAGE

1. Drain valves shall be installed at all low points in all piping systems to allow for complete drainage of piping systems.

2. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

3. All piping systems shall be installed so that they can be easily drained by means of drainage of low points of all piping without disconnecting pipe.

4. If not specifically indicated on the drawings, the frequency of draining shall determine whether drain caps, plugs, cocks, or valves are to be used.

G. IDENTIFICATION

1. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

3.3 DIELECTRIC FITTING INSTALLATION

A. Make connections according to the following, unless otherwise indicated:

1. Install dielectric nipples or waterways in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install waterways, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Install Dielectric Fittings into Hydronic Piping Systems: Install dielectric nipples, waterways or couplings to connect piping materials of dissimilar metals.
4. **End Connections**: Threaded, or flanged.

3.4 **HANGERS AND SUPPORTS**

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Steel roof deck shall not be used to support loads from piping, ductwork or equipment, unless noted otherwise. Hanger loads less than 50 lbs. may be hung from the steel roof deck in cases when hanging from the steel roof deck cannot be avoided; the attachment method must distribute the load across the deck as approved by the Structural Engineer.

D. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

E. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
6. NPS 3 and Larger: Maximum span, 12 feet; minimum rod size, 1/2 inch.

F. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

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.


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 D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

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 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydraulic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 2113
SECTION 23 2116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes special-duty valves and specialties for the following:
   1. Hot-water heating piping.
   2. Air-vent piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air-control devices.
   3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 VALVES

A. Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping. Gate valves are not allowed on this project.
B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."

C. Refer to Part 3 “Valve Applications” Article for applications of each valve.

D. Bronze, Calibrated-Orifice or Venturi, Balancing Valves, NPS 2 and smaller:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump.
   c. Flow Design Inc.
   d. Gerard Engineering Co.
   e. Griswold Controls.
   f. Taco.
   g. Tour & Andersson; available through Victaulic Company.
   h. Nexus Valve, Inc.
   i. NIBCO, Inc. (S/T/PC-1910 or S/T/PC-1805)

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
8. Handle Style: Lever, with memory stop to retain set position.
10. Maximum Operating Temperature: 250 deg F.

E. Cast-Iron or Steel, Calibrated-Orifice or Venturi, Balancing Valves, NPS 2 ½ and larger:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Flow Design Inc.
   e. Gerard Engineering Co.
   f. Grinnell.
   g. Griswold Controls.
   h. Taco.
   i. Tour & Andersson; available through Victaulic Company.
   j. Spence Engineering Company Inc.
   k. Watts Regulator Co.
   l. Nexus Valve, Inc.
   m. NIBCO, Inc. (F-737 OR F-739)
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
9. Handle Style: Lever, with memory stop to retain set position.
11. Maximum Operating Temperature: 250 deg F.

F. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Conbraco Industries, Inc.
   e. Kunkle.
   f. Spence Engineering Company, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
8. Inlet Strainer: Brass, removable without system shutdown.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

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 Domestic Pump.
   d. Taco, Inc.

2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Manually operated with ball valve in the down position.
8. CWP Rating: 150 psig.
9. Maximum Operating Temperature: 225 deg 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 Domestic Pump.
   c. Hoffman Specialty ITT; Fluid Handling Div.
   d. Spirax-Sarco.
   e. Spirovent.
   f. Taco, Inc.
   g. Honeywell-Baukman.

2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
5. Inlet Connection: NPS 1/2.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

2.3 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Hoffman Specialty ITT; Fluid Handling Div.
   c. Metraflex Co.
   d. Mueller
   e. Spirax Sarco.
   f. Trane Co.
   g. Tour & Andersson; available through Victaulic Company.
   h. Watts Regulator Co.
   i. Nexus Valve

2. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: threaded ends for NPS 2 and smaller, flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: Stainless-steel, or perforated stainless-steel basket:
   a. 20-mesh strainer.
5. CWP Rating: **125 psig.**

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. **Install calibrated-orifice**, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Automatic air vents may cause damage to ceilings and other finished surfaces. Air vents aid in system filling. Air removal after initial startup is accomplished by air separator or boiler diptube. Manual air vents may be a better solution.

C. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

E. Install in-line air separators in pump suction. Install drain valve on air separators **NPS 2** and larger.

F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

**END OF SECTION 23 2116**
SECTION 23 2123 - HYDRONIC PUMPS

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:

2. Separately coupled, horizontally mounted, in-line centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, shipping weights, installed weights, 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. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.
   a. Detail all wiring systems and differentiate clearly between manufacturer-installed and field-installed 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.

1.7 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

C. Regulatory Requirements: Fabricate and test steam condensate pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Pumps Inc.
2. ITT Corporation; Bell & Gossett.
4. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded or threaded companion-flange or union-end connections or unions at connections for casings that are not available with threaded companion flanges.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.

3. **Pump Shaft**: Steel, with oil lubricated copper-alloy shaft sleeve.

4. **Seal**: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

5. **Pump Bearings**:
   1. Oil lubricated, **bronze-journal**.

D. Motor: Single speed and rigidly or resiliently mounted to pump casing.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   a. **Enclosure**: Open, dripproof.
      1) **Cast iron**.
   b. **Motor Bearings**:
      1) **Grease-lubricated ball bearings**.
      2) **Premium efficient**.
   c. **Service Factor**: 1.15.

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 according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

B. Comply with HI 1.4.

C. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

E. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers elastomeric hangers of size required to support weight of in-line pumps.

   1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

   2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft.

C. Comply with pump and coupling manufacturers' written instructions.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section "Heating Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install check, shutoff, and throttling on discharge side of pumps.

E. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
F. Install shutoff valve on suction side of vertical-inline pumps.

G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

H. Install thermometers at pump suction and discharge.

I. Install check valve and gate or ball valve on each condensate pump unit discharge.

J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Perform the following startup checks for each pump before starting:
      
      a. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
      b. Verify bearing lubrication.
      c. 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.
      d. 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. Open cooling water-supply valves in cooling water supply to bearings, where applicable.
   7. Open cooling water-supply valves if stuffing boxes are water cooled.
   8. Open sealing liquid-supply valves if pumps are so fitted.
   9. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
   10. Open circulating line valves if pumps should not be operated against dead shutoff.
   12. Open discharge valve slowly.
13. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
14. Check general mechanical operation of pumps and motors.
15. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.

B. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Review data in maintenance manuals. Refer to Division 1 Section Contract Closeout.
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 23 2123
SECTION 23 2301 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

B. Related Sections:

1. Section 23 5758 “VRF Heat Recovery Systems”.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:

a. Service valves and packed angle valves.

B. Shop Drawings:

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

A. Section 608 Certificates.

B. Field quality-control reports.
1.5  CLOSEOUT SUBMITTALS

A.  Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6  QUALITY ASSURANCE

A.  Contractor Qualifications: Utah State licensed refrigeration contractor with technicians with Section 608 Certification.


C.  Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7  PRODUCT STORAGE AND HANDLING

A.  Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1  PERFORMANCE REQUIREMENTS

A.  Line Test Pressure for Refrigerant R-410A:


2.2  COPPER TUBE AND FITTINGS

A.  Copper Tube: ASTM B 280, Type ACR and ASTM B 88, Type L.

B.  Wrought-Copper Fittings: ASME B16.22.

C.  Wrought-Copper Unions: ASME B16.22.

D.  Brazing Filler Metals: AWS A5.8/A5.8M.

2.3  VALVES AND SPECIALTIES

A.  Service Valves:

   1.  Body: Forged brass with brass cap including key end to remove core.
   2.  Core: Removable ball-type check valve with stainless-steel spring.
   4.  End Connections: Copper spring.
B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
5. Seal Cap: Forged-brass or Valox (glass-fiber reinforced plastic) hex cap.
6. End Connections: Socket, union, threaded, or flanged.
8. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Hot-Gas, Liquid Lines and Suction Lines: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Safety-Relief-Valve Discharge Piping: Copper, Type L or Type ACR, annealed or drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves in incoming and outgoing branches to allow service to any Refrigerant Distribution Box.

B. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

C. Install service packed-angle valves in suction and discharge lines of compressor.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 23 5758 “Variable Refrigerant Flow Heat Recovery Systems” and Section 230900 "Building Automation Systems" for controls, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 3113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

O. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC".
T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC".

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with nitrogen during brazing to prevent scale formation. If it is observed that refrigerant lines are being or have been brazed without proper circulation of nitrogen through lines, all refrigerant lines installed up to that point in time shall be removed and replaced at no additional cost to the owner.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Copper socket fittings with copper pipe: Type BCuP-4 or Type BCuP-5 (copper-phosphorus) alloy for joining.
   2. Copper with bronze or steel: Type BAg-5 (cadmium-free, 45% silver) alloy for joining.

3.5 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
   1. NPS 1/2 and NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
   2. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
   3. NPS 1-1/4 through NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
   4. NPS 2-1/2 and NPS 3: Maximum span, 108 inches; minimum rod, 3/8 inch.

D. Support multi-floor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
   a. Fill system with oxygen-free nitrogen (OFN) to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Triple Evacuation:
      a. Evacuate entire refrigerant system with vacuum pump to 4000 micrometers from both service valves; Break vacuum with OFN into discharge service valve to 0 psi.
      b. Evacuate entire refrigerant system with vacuum pump to 1500 micrometers from both service valves; Break vacuum with OFN into discharge service valve to 0 psi.
      c. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers from both service valves for a minimum of 1-hour.
      d. Conduct a Vacuum Rise Test for minimum of 30 minutes.
   3. Break vacuum with refrigerant gas, allowing pressure to build to 2 psig.
   4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Engage a Factory-authorized Service Representative to perform startup service
   1. Complete installation and startup checks according to manufacturer’s written instructions.
2. Prepare written report of findings and recommended corrective actions signed by the Factory-authorized Representative. Submit written report to Architect along with copies of completed installation and startup checklists.

END OF SECTION 23 2301
SECTION 23 2500 – HVAC WATER TREATMENT

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 the following water treatment for closed-loop hydronic systems:
   2. HVAC System cleaning and treatment Chemicals. For new portion of heating water piping installed in these documents.

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. Chemical test equipment.
   3. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.
   1. Include plans, elevations, sections, and attachment details.
   2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. 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 and applying water treatment as specified in this Section.

B. Mechanical Equipment Contractor: Responsibilities to include installation of water-treatment equipment under the direction of the HVAC Water-Treatment Service Provider (above).

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 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. Initial and periodic water analysis and 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. At quarterly intervals following Substantial Completion provide field service and consultation.
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 by one of the following:

1. Power Engineering Co. (PECO)
2. WEST Inc.
2.2 PERFORMANCE REQUIREMENTS

A. 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.

B. HVAC water treatment and cleaning formulated based on the water quality at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction. New portion of heating water system only.

C. Closed hydronic systems, shall have the following water qualities:

1. Closed hydronic systems, including:
   a. Heating – glycol/water system;

2. pH: Maintain a value within 8.8 to 9.5
3. Nitrite: Maintain a value within 800 to 1000 ppm.
4. Soluble Copper: Maintain copper coupon corrosion rates less than 0.20 mpy.
5. TDS: Maintain a maximum value of 3000 ppm
7. Microbiological Limits:
   a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
   b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
   c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
   d. Sulfate Reducers: Maintain a maximum value of zero (0) organisms/mL.
   e. Iron Bacteria: Maintain a maximum value of zero (0) organisms/mL.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.


2.4 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing: total hardness drop, phosphate, sodium nitrate, for closed hydronic systems.

2.5 CHEMICALS

A. 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.
B. Propylene Glycol shall be DowFrost HD propylene glycol as manufactured by Dow Chemical or JeffCool HD propylene glycol as manufactured by Huntsman Chemical. Water quality in the hot/chilled water system shall meet the recommendations of the glycol manufacturer so as to prevent formation of sludge. If the water quality at the jobsite does not meet manufacturers recommendations then the glycol solution shall be provided pre-mixed with deionized water. An analysis of the glycol solution and the water quality shall be included in the O&M manuals. Glycol percentage shall be: 30% by volume.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Contractor Responsibilities:

1. Water Treatment Contractor:
   a. Provide water treatment equipment.
   b. Provide fluids,
   c. Chemicals.
   d. Make adjustments.

2. Mechanical Contractor:
   a. Install equipment per Water Treatment Contractors instructions.

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. Bypass Feeders: Install in closed hydronic systems, and equipped with the following:

   1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
   2. Install full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
   3. Install a swing check on the inlet after the isolation valve.

E. Cleaning:

   1. After completing system installation, inspect exposed finish. Remove burrs, dirt. And construction debris; repair damaged finishes, including chips scratches and abrasions.
   2. Ensure system is operational, filled, started and vented prior to cleaning. Place terminal control valves in OPEN position during cleaning. Use water meter to record capacity of each system. For hot-water systems, apply heat and slowly rise system to design temperature.
3. Add cleaning chemicals as recommended by manufacturer. Circulate for 48-hours, then drain. Refill with clean water and circulate for 24-hours, then drain. Refill with clean water and repeat until system cleaning chemicals are removed.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."

C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."

D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in make-up-water connections to potable-water systems.

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 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. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.

4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

5. 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.

6. 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.

7. 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.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.

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

D. Prepare written test and inspection reports. Include written reports with Close Out Submittals.
E. At quarterly intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that manual chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Meet and consult with Owner’s maintenance personnel. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article. In glycol systems, measure and maintain glycol concentration, inhibitors and reserve alkalinity as recommended by glycol manufacturer.

F. Comply with ASTM D 3370 and with the following standards:

5. Copper: ASTM D 1688
6. pH: ASTM D 5464

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to adjusting, operating, startup and shutdown; troubleshooting; servicing and preventative maintenance of the HVAC Water Treatment Systems.

1. Review data in the Operation and Maintenance Manual. Refer to Division 1 Section “Contact Closeout”.
2. Schedule training with Owner through the Architect with at least 14 days advance notice.

END OF SECTION 23 2500
SECTION 23 3001 - COMMON DUCT REQUIREMENTS

PART 1 - PRODUCTS

1.1 SUMMARY

A. Includes But Not Limited To:

1. General procedures and requirements for ductwork.
2. Repair leaks in ductwork, as identified by smoke test, at no additional cost to Owner.
3. Soundproofing procedures for duct penetrations of walls, ceilings, and floors in mechanical equipment rooms.

B. Related Sections:

1. Division 07: Quality of Acoustic Sealant.
2. Section 23 0500: Common Work Results for HVAC
3. Section 23 0593: Testing Adjusting and Balancing for HVAC.

1.2 SUBMITTALS

A. Samples: Sealer and gauze proposed for sealing ductwork.

B. Quality Assurance / Control:

1. Manufacturer’s installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.
2. Specification data on sealer and gauze proposed for sealing ductwork.

1.3 QUALITY ASSURANCE

A. Requirements: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.

B. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.

PART 2 - PRODUCTS

2.1 Finishes, Where Applicable: Colors as selected by Architect.

2.2 Duct Hangers:

A. One inch by 18 ga galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 96 inches apart. Do not use wire hangers.
1. Attaching screws at trusses shall be 2 inch No. 10 round head wood screws. Nails not allowed.

2. Attach threaded rod to steel joist with Grinnell Steel washer plate Fig. 60 - ph-1. Double nut connection.

2.3 Penetration Soundproofing Materials:

A. Insulation for Packing: Fiberglass.

B. Calking: Polysulphide.

C. Escutcheon Frame: 22 ga galvanized iron 2 inches wide.

PART 3 - EXECUTION

3.1 INSTALLATION

A. During installation, protect open ends of ducts by covering with plastic sheet tied in place to prevent entrance of debris and dirt.

B. Make necessary allowances and provisions in installation of sheet metal ducts for structural conditions of building. Revisions in layout and configuration may be allowed, with prior written approval of Architect. Maintain required airflows in suggesting revisions.

C. Hangers And Supports:
   1. Install pair of hangers close to each transverse joint and elsewhere as required by spacing indicated in table on Drawings.
   2. Install upper ends of hanger securely to floor or roof construction above by method shown on Drawings.
   3. Attach strap hangers to ducts with cadmium-plated screws. Use of pop rivets or other means will not be accepted.
   4. Where hangers are secured to forms before concrete slabs are poured, cut off flush all nails, strap ends, and other projections after forms are removed.
   5. Secure vertical ducts passing through floors by extending bracing angles to rest firmly on floors without loose blocking or shimming. Support vertical ducts, which do not pass through floors, by using bands bolted to walls, columns, etc. Size, spacing, and method of attachment to vertical ducts shall be same as specified for hanger bands on horizontal ducts.

D. Penetration Soundproofing
   1. Pack space between ducts and structure full of fiberglass insulation of sufficient thickness to be wedged tight, allowing space for application of calking.
   2. Provide calking at least 2 inches thick between duct and structure on both ends of opening through structure.
   3. Provide metal escutcheon on Equipment Room side. Secure escutcheon to wall.
3.2 CLEANING

A. Clean interior of duct systems before final completion.

END OF SECTION 23 3001
SECTION 23 3113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Duct liner.
3. Sealants and gaskets.
4. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
3. Section 230713 “Duct Insulation” for duct insulation and fire wrap.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
13. Duct fabrication shall not begin until shop drawings have been submitted and reviewed by the mechanical engineer.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. **Design Calculations:** Calculations for selecting hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including, but not limited to the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

B. Field quality-control reports.
1.6 QUALITY ASSURANCE


B. Welding Qualifications: Qualify procedures and personnel according to the following:


C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Duct dimensions shown on drawings are inside clear dimensions.

E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

B. Duct dimensions shown on drawings are inside clear dimensions.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

H. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent. Inner duct shall be solid sheet steel a minimum of 10 feet downstream of humidifiers or air washers.

I. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

J. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-
support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
   2. Maximum Thermal Conductivity:
      a. Type I, Flexible: \(0.27 \text{ Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.}\)
      b. Type II, Rigid: \(0.23 \text{ Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.}\)
   3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   4. Water-Based Liner Adhesive:
      a. Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
b. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. 0.135-inch-diameter shank.
2. Insulation-Retaining Washers: With beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Self-locking washers formed from 0.016-inch-thick aluminum.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
8. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.
2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
E. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.
   6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.
3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 2 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.


3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
4. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with the requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.

   2. Any liner showing evidence that is has wet at any time shall be removed and replaced with new liner.
      a. Disinfect affected sheet metal, and pins.
      b. Install new liner per specifications
c. Seal friable edges and seams of repaired liner.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new duct system before testing, adjusting, and balancing.

B. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel.

B. Ductwork running in areas where there are no ceilings or when noted on the drawings shall be doubled wall duct and shall meet the requirements indicated below.

C. Supply Ducts:

1. Ducts Connected to Constant-Volume Air-Handling Units:

   a. Pressure Class: Positive 2-inch wg.

   b. Minimum SMACNA Seal Class: A.

   c. SMACNA Leakage Class for Rectangular: 8.

D. Liner: (Ductwork located in Unconditioned space)

1. Low Pressure Supply Air Ducts (Less than 2000 FPM velocity): Fibrous glass, Type I, 1-1/2 inch thick with a minimum R value of 6.0 for ducts in unconditioned spaces.

E. Liner: (Ductwork located Interior to building Insulated Envelope)

1. Low Pressure Supply Air Ducts (Less than 2000 FPM velocity): Fibrous glass, Type I, 1 inch thick with a minimum R value of 4.0 for ducts in unconditioned spaces.
F. Exterior Ductwork Liner Insulation:

1. Supply Air Ducts: 2 inch thick with a minimum R value of 8.0.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   
a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   
a. Rectangular Main to Rectangular Branch: 45-degree entry high efficiency take-off.
   
b. Rectangular Main to Round Branch: 45-degree entry high efficiency take-off.

END OF SECTION 23 3113
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Listed **double-wall vents**.
2. Field-fabricated metal breechings.

3. CATEGORY IV, CONDENSING BOILERS, SPECIAL GAS VENTS
   a. Listed:
      1) **Double-wall vents**.
   b. This section specifies:
      1) Category IV vents/chimneys.
      2) Special Gas Units.
      3) Condensing Boilers – positive pressure.

B. Related Sections include the following:

1. Section 235113 "Draft Control Devices" for induced-draft and mechanical fans and for
   motorized and barometric dampers.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Special gas vents. (Category IV, Condensing Boilers, Special Gas Vents).
   2. Building-heating-appliance chimneys. (Forced Draft Boilers).

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations,
   sections, details, and attachments to other work.

   1. Detail equipment assemblies and indicate dimensions, weights, loads, required
      clearances, methods of field assembly, components, hangers and seismic restraints, and
      location and size of each field connection.
   2. For installed products indicated to comply with design loads, include calculations
      required for selecting seismic restraints and structural analysis data signed and sealed by
      the qualified professional engineer responsible for their preparation.
1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated breeching, chimneys, and stacks; accessories; and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Breeching, Chimneys, and Stacks: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of anchorage devices on which the certification is based and their installation requirements.

C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.


C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

D. Verification: Flue type to be verified by the boiler manufacturer of the submitted boiler.

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
1. Warranty Period: To cover the following number of years from date of Substantial Completion:
   a. 10 years.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENTS (POSITIVE PRESSURE FLUES)

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. Duravent
2. Heat-Fab, Inc.
3. Z-Flex; a division of the Novaflex Group.

B. 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.

C. Vent shall be factory-built special gas type, double wall, engineered and designed for use on Category IV appliances, or as specified by the equipment manufacturer.

D. Maximum continuous flue gas temperature not to exceed 550° F for gas burning appliances.

E. Construction: Inner conduit and outer wall casing shall be constructed with a one-inch air space between them and in such a fashion that prevents cross-alloy contamination. Optional 1” fiber insulation is available to maintain higher flue temperatures, but does not reduce clearances beyond the standard clearances tested for 1” air space model CI Plus.

F. Inner Shell: Vent shall be constructed with an inner conduit constructed of ASTM A 959, Type 29-4C or 2904 superferritic stainless steel with a minimum thickness of 0.015” for diameters of 3” to 8”, 0.20” for diameters of 10” to 16”, 0.025 for diameters 18” to 24”, and 0.035” for 26” and greater.

G. Outer Jacket: The outer wall casing shall be constructed of 430 stainless steel that shall not require additional surface preparation, such as painting, in order to withstand the outdoors or high humidity environments.

H. The joint closure shall be an inner wall mechanical locking strap design. Joints shall not use screws or fasteners that penetrate the inner conduit.

I. General Electric RTV105 or Down Corning 736 high temperature sealant shall be used to seal all joints on systems where the maximum flue gas temperature will not exceed 550° F or a factory installed 550° F compatible silicone rubber gasket shall be used to seal joints.

J. Vent shall be listed for an internal static pressure of 15” w.g. and tested to 37” w.g.

K. Vent shall be constructed with a factory installed gasket used to seal the joint for diameters 4” to 16”. Use of gasket lube, available from the factory, should be used for maximizing gasket life and ease of installation. For diameters 18” to 32”, joints shall be sealed with factory supplied RTV sealant.
L. Tees and elbows shall provide a pressure drop less than 15 feet equivalent horizontal vent.

M. Fittings that increase or decrease vent diameter shall be asymmetric in construction with a flat wall that maintains a straight line with adjoin parts in order to facilitate the unobstructed flow of all condensate.

N. 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.

1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
3. Termination: Exit cone with drain section incorporated into riser.

O. All parts shall be compatible with other single wall and double wass products of the same manufacturer.

P. System is to be sized in accordance with the appliance manufacturer’s specifications, NFPA 54 National fuel Gas Code (ANSI Z223.1), ASHREA recommendations, and other applicable codes.

2.2 GUYING AND BRACING MATERIALS

A. Cable: Three galvanized, stranded wires of the following thickness:

1. Minimum Size: 1/4 inch in diameter.
2. For ID Sizes 4 to 15 Inches: 5/16 inch.
3. For ID Sizes 18 to 24 Inches: 3/8 inch.
4. For ID Sizes 27 to 30 Inches: 7/16 inch.
5. For ID Sizes 33 to 36 Inches: 1/2 inch.
6. For ID Sizes 39 to 48 Inches: 9/16 inch.
7. For ID Sizes 51 to 60 Inches: 5/8 inch.

B. Pipe: Two galvanized steel, NPS 1-1/4.

C. Angle Iron: Two galvanized steel, 2 by 2 by 0.25 inch.

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.

1. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 APPLICATION

A. Listed Special Gas Vent: Condensing gas appliances.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to 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 and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Lap joints in direction of flow.

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. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 23 5100
SECTION 23 5216 - CONDENSING BOILERS

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 natural gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

B. Division 23 shall arrange and pay for State of Utah Boiler inspection and Inspection Certificate.

1.3 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 boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, and Appendix N.

E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to Authority Having Jurisdiction (AHJ).

F. Mounting Base: For securing boiler to concrete base.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.

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 boilers.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories. Capacity values shall be de-rated based on the project altitude.

B. Shop Drawings: For boilers, boiler trim, and accessories.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Space in boiler room is limited. Alternate manufacturer must demonstrate how their boilers fit into the boiler room while maintaining recommended clearances.
   3. Include diagrams for power, signal, and control wiring.
   4. Include boiler flue and combustion air duct schematic drawing showing all flue and duct sizes, lengths, fittings and terminations based on field measurement of actual conditions.

C. [Draft Analysis: Factory boiler flue and combustion air duct Draft Analysis based on the shop drawings using actual sizes, lengths and fittings; and the project altitude.

D. INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on:
      a. Test of assembled components by a nationally recognized testing standard procedure, such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demand determined by Section 13.3 of ASCE 7.
      b. An engineering analysis conforming to the requirements of Chapter 13 of ASCE 7.
      c. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
   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. Source quality-control reports.
   1. Factory burner and hydrostat tests.
   2. Factory inspections and testing done in accordance with 2010 ASME Boiler and Pressure Vessel Code

C. Field quality-control reports.
   1. Start checklists and testing performed by Factory-authorized Service Representative.
   2. Performance testing performed by Factory-authorized Service Representative.

D. Sample Warranty: For special warranty.

E. Other Informational Submittals:
1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY
A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:
   a. Leakage and Materials: ten (10) years from date of Substantial Completion.
   b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Non-prorated for five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. AERCO International, Benchmark Series.
   2. Cleaver Brooks, Clearfire Series.
   3. Lochinvar, Crest Series.
   4. Viessmann, Vitoplex Series.

2.2 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS
A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water-heating service only.

B. Heat Exchanger: Stainless Steel, corrosion-resistant combustion chamber.

C. Burner: Natural gas, forced draft.

D. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   a. 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.

E. Gas Train: Control devices and modulating control sequence shall comply with ASME CSD-1 requirements.

F. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

G. Casing:
   1. Jacket: Sheet metal, with snap-in or interlocking closures.
   2. Control Compartment Enclosures: NEMA 250, Type 1A.
   4. Insulation: Minimum 2-inch thick, polyurethane-foam insulation surrounding the heat exchanger.

H. Capacities and Characteristics:
   1. Comply with the pressures, temperatures, flow rates, efficiencies and electrical characteristics as scheduled in the project Plans.

2.3 TRIM

A. Include devices sized to comply with ASME B31.1.

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated, pressure rating as scheduled on Drawings.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.

F. Drain Valve: Minimum NPS-3/4 ball valve with hose-end and cap.

G. Condensate Trap: Provided by manufacturer.

H. Condensate Neutralization Tank: Provide by manufacturer with limestone chips.

I. Isolation Valve: Two-way motorized butterfly valve. Valve body shall comply with requirements listed in Section 23 0523 “General-Duty Valves for HVAC Piping”. Valve actuator shall comply with Section 23 0900 "Building Automation System" and shall be compatible with the boiler manufacturer's controls.
2.4 CONTROLS

A. Refer to Section 230900 "Building Automation System" "Sequence of Operation."

B. Boiler Management System: microprocessor based complete integrated system to control operations and energy input into the boiler plant. The boiler management system may be integrated into each boiler OR may be a standalone controller mounted separate from the boilers.

1. Sequencing Capability: 2 to 8 boilers to meet system load.
2. Boiler Operation: Automatically rotate lead/lag among the boilers on system; monitor run hours per boiler; and balance load to maintain equalize boiler run hours.
3. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
5. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
6. Control wiring: Control wiring per the manufacturer’s written instructions shall be by the Controls Contractor, refer to Section 230900 "Building Automation System".
7. Optional Valve: Integrated control and wiring for optional isolation valve. Isolation valves are utilized; the Boiler Management System shall operate one motorized valve per boiler as an element of load sequence. Valves shall close as boilers turn off with decreased load; a minimum of one valve must always be open.

C. Building Automation System (BAS) Interface: Factory installed hardware and software to enable the BAS to remotely monitor, control, and display boiler status and alarms from a BAS operator workstation.

1. Hardwired Points:
   b. Control: Enable/disable operation and hot-water-supply temperature set-point adjustment (with 4-20 ma signal from the BAS).

2. Communication: LONworks or BACnet (ASHRAE 135) BACnet IP.
3. Controlled Features:
   a. Alarms and alarm history.
   b. Monitored points displayed locally at boiler control panel shall be available through BAS.

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to fused disconnect switch.
5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

2.6 VENTING KITS

A. Refer to “Special Gas Vent” requirements Section 235100 “Breechings, Chimneys, and Stacks”.

B. Kit: Complete Category IV (positive pressure, fully condensing) system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and neutralization tank, and sealant. Or single wall, factory-built type, designed for use in conjunction with Category II, or IV condensing gas fired appliances, or as specified by the equipment manufacturer.

C. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

D. Flue manufacturer shall provide a draft analysis and shop drawings of the boiler combustion air and exhaust flue system based on actual project conditions including actual duct lengths; actual elbows and other fittings; vent terminations and actual boiler requirements. All calculations and selections shall be at project altitude.

2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
1. Final boiler locations indicated on Drawings are approximate. Determine exact locations based on the provided equipment before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment bases. Concrete equipment bases shall comply with overall size, thickness, and edge distance for anchor bolts required in Section 230548 “Vibration and Seismic Controls” Submittal.

2. Equipment Bases: Comply with requirements specified in Section 033053 "Miscellaneous Cast-in-Place Concrete".

3. Vibration Isolation and Seismic Control: Comply with requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install field-mounted equipment (condensate traps, condensate neutralization tanks, etc.) furnished with the boiler but factory mounted.

D. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve.

E. Connect piping to boilers mounted on vibration isolators, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."

F. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

G. Connect hot-water piping to supply and return boiler tapings with shutoff valve and union or flange at each connection.
H. Install piping from safety relief valves to nearest floor drain.

I. Boiler Venting:
   1. Install flue venting kit and combustion-air intake.
   2. Connect full size to boiler connections.
   3. Comply with “Special Gas Vent” requirements in Section 235100 "Breachings, Chimney and Stacks"

J. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

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

D. Prepare written test and inspection reports, with findings and corrective actions. Submit written report to Architect.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to four visits to Project during other-than-normal occupancy hours for this purpose.

F. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
   3. Perform field performance tests to determine capacity and efficiency of boilers.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
7. Notify Architect 10 days minimum in advance of test dates.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing and preventive maintenance of boilers.

1. Review data in the Operation and Maintenance Manual. Refer to Division 1 Section “Contract Closeout”.
2. Schedule training with Owner through Architect with at least 10-days advance notice.

END OF SECTION 23 5216
SECTION 23 5758 - VARIABLE REFRIGERANT FLOW (VRF) HEAT RECOVERY 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. Installer qualifications
   2. Heat recovery systems
   3. Controls

B. Related Sections:
   1. Section 23 2300 "Refrigerant piping" for refrigerant piping and specialties for refrigeration systems.
   2. Section 23 0900 "Building Automation System" for interface with Building Management System

1.3 SYSTEM DESCRIPTION

A. The variable capacity, heat recovery system shall consist of an outdoor unit, heat recovery distribution boxes, multiple indoor units, and DDC (Direct Digital Controls). Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. To ensure owner comfort, each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for ten minutes. The sum of connected capacity of all indoor air handlers shall range from 50% to 125% of outdoor rated capacity.

1.4 SUBMITTALS

A. Contractor Qualifications: Approved installers must be factory trained and certified. Submit the following:
   1. Manufacturer training certification.
   2. List of (5) projects of similar design, size and complexity. Provide information of equipment provided including manufacture.
B. Piping/Control Schematics: All manufacturers shall submit full piping, and control schematics with derated performances. All capacity values submitted shall reflect derations reflecting the projects elevation, ambient conditions, defrost mode, piping lengths, and humidity levels.

C. Alternate Design: If an alternate manufacturer is selected than the manufacturer as listed in the schedules, any additional material, cost, engineering or labor required to provide a complete and working installation shall be incurred by the contractor. Provide a coordination set of drawings indicating all piping, controls, electrical, mechanical, etc modifications and deviations from the basis of design.

D. Factory-authorized service representative: Submit factory-authorized service representative’s qualifications including documentation of manufacturers service certification.

E. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

F. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

G. Samples for Initial Selection: For units with factory-applied color finishes.

H. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control reports as outlined in Section 3 of this specification including the following:
   1. Pre-Construction meeting minutes
   2. Site Observation Reports
   3. Controls start-up and commissioning report
   4. Piping Evacuation and Pressure Testing reports

B. Operation and Maintenance Data: For each piece of equipment to include in emergency, operation, and maintenance manuals.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate sizes and locations of concrete pads, equipment supports, and anchors with actual equipment provided.
1.7 QUALITY ASSURANCE

A. Installer Qualifications:
   1. The system must be installed by experienced factory trained installers who have designed
      and installed Variable Flow Refrigerant (VRF) Heat Recovery Systems similar to that
      indicated for this Project and obtained design approval and inspection approval from
      authorities having jurisdiction. The Engineer requires evidence to support the ability of
      the contractor to perform work in the scope and volume as specified. A contractor, who
      cannot show such experience, may be found not suitable to perform the work. The
      following are the approved for this project:

B. Pre-approved refrigeration installers, LG:
   1. B2 Air
   2. DB Service
   3. Total Air Handling
   4. Cherrington
   5. MJ Mechanical

C. Pre-approved refrigeration installers, Mitsubishi:
   1. Gunthers Comfort Air
   2. Harris Mechanical
   3. Utah Engineering
   4. Rocky Mountain Mechanical
   5. Carment Refrigeration

D. Pre-approved refrigeration installers, Daikin:
   1. US Mechanical
   2. B2 Air Systems
   3. Hustad Mechanical
   4. D&B Services

E. Pre-approved control installers, LG:
   1. B2 Air
   2. Utah Yamas Controls
   3. Total Air Handling
   4. Cherrington
   5. MJ Mechanical

F. Pre-approved control installers, Mitsubishi:
   1. Gunther’s Comfort Air
   2. Harris Mechanical
   3. Utah Engineering
   4. Rocky Mountain Mechanical
   5. Utah Yamas Controls

G. Pre-approved control installers, Daikin:
   1. US Mechanical
   2. B2 Air Systems
   3. Hustad Mechanical
   4. Utah Yamas Control
H. Pre-approved factory-authorized service representative, LG:
   1. MHI Service LG Certified.

I. Pre-approved factory-authorized service representative, Mitsubishi:
   1. APS Diamond Service Group Certified.

J. Pre-approved factory-authorized service representative, Daikin:
   1. MPI Service Daikin Certified.

K. The units shall be listed by Electrical Laboratories (ETL) and bear the cETL label.

L. All wiring shall be in accordance with the National Electric Code (NEC).

M. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by
   the International Standard Organization (ISO). The system shall be factory tested for safety and
   function.

N. The outdoor unit will be factory charged with R-410A.

1.8 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendations.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or
   replace components of VRF system that fail in materials or workmanship within specified
   period.

   1. Parts Warranty Period: Five (5) year from date of Substantial Completion.
   2. Compressor Warranty Period: Five (5) years from date of Substantial Completion.

1.10 QUALITY ASSURANCE

A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a
   set of standards applying to environmental protection set by the International Standard
   Organization (ISO).

D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the
   proposed ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be
   published in accordance with the DOE alternative test procedure, which is based on the Air-
   Standard 13256-1.

E. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.
PART 2 - PRODUCTS

2.1 VARIABLE REFRIGERANT FLOW (VRF); HEAT RECOVERY SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. LG
   2. Mitsubishi
   3. Daikin Industries.

2.2 OUTDOOR UNITS

A. General:
   1. The outdoor unit shall be used specifically with manufacturers components. The outdoor units shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.

2.3 BRANCH CIRCUIT CONTROLLERS/HEAT RECOVERY UNITS

A. General
   1. Factory assembled internal valves, piping and wiring.

B. Refrigerant
   1. R410A refrigerant shall be required.

C. Refrigerant valves:
   1. Provide refrigeration control valves and service valves.

2.4 INDOOR UNITS

A. General:
   1. Indoor units are ceiling cassette style or concealed ducted indoor fan coil style.

B. Indoor Unit.
   1. The indoor unit shall be factory assembled, wired and run tested.

C. Unit Cabinet:
   1. The cabinet shall be ceiling cassette style or ceiling-concealed, ducted.

D. Fan:
   1. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.

E. Filter:
1. Ceiling cassette style shall have integral filters, fan coil style shall have field installed filters. Installing contractor shall provide filter racks to incorporate MERV 8 filters for each unit.

F. Condensate Pump with safety shut-off switch.

G. Coil:
1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. All tube joints shall be brazed with phos-copper or silver alloy.
3. The coils shall be pressure tested at the factory.
4. A condensate pan and drain shall be provided under the coil.
5. The condensate shall be pumped to a gravity drain.

H. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

I. Controls:
1. This unit shall use controls provided by the manufacturer to perform functions necessary to operate the system.
2. Indoor unit shall be controlled by a wall air sensor.

2.5 CONTROLS

A. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

B. Communication interface with building automation system shall enable building automation system operator to remotely control and monitor the VRF system from an operator workstation. Control features and monitoring points displayed locally at VRF control panel shall be available through building automation system.
1. The format for the Building Automation System Interface shall be:
   a. ASHRAE 135 (BACnet). Must be BACnet IP (not MSTP or Ethernet).

C. All installation of low voltage wiring shall be the responsibility of this section.

D. System controls and control components shall be installed in accordance with the manufacturer’s written installation instructions and Division 26.

E. Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.

F. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.
G. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.

H. System shall be capable of email generation for remote alarm annunciation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices.

C. Retain first paragraph below if Project is in a seismic area.

D. Install seismic restraints.

E. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch.

F. Install and connect tubing to components. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts" Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a pre-approved factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. The credentials of the personal who will be actually doing the startup shall be submitted with the submittals for approval. The contractor is not to be the qualified factory-authorized service representative. The following field-observations shall be conducted by the factory-authorized service representative.

1. Pre-construction Meeting
2. Minimum (2) Site Observations
3. Evacuation and Pressure Testing Observation
4. Control Start-up
5. Equipment and System Start-up.

VARIABLE REFRIGERANT FLOW HEAT RECOVERY SYSTEM
6. Assist 23 0900 Contractor as needed to obtain a complete operating system to the owners satisfaction. This includes any help in relation to integrated points that are provided with the interface including proper point configuration for occupancy, modes of operation, etc.

B. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a pre-approved factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Training for Owner's maintenance personnel on site shall be a minimum of (8) hours.

3.6 OWNERS TRAINING AND CERTIFICATION

A. Manufacturer shall provide training for Ogden School District personnel to attend a factory training for the Variable-Refrigerant-Flow systems. Training shall include air and ground transportation to and from Salt Lake City to the factory training site, tuition, lodging, meals and any other expenses related to this training. The training course shall provide an in-depth functional study of the system along with a discussion of the theories associated with properly applying, installing, commissioning and troubleshooting systems.

<table>
<thead>
<tr>
<th>System Training</th>
<th>Controls Specific Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training Duration</td>
<td>3 to 5 days</td>
</tr>
<tr>
<td>Owner Personnel Trained: 4 People</td>
<td>2 people</td>
</tr>
</tbody>
</table>

END OF SECTION 23 5758
SECTION 23 7433 – PACKAGED MAKE-UP AIR UNIT WITH HEATING

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 factory-packaged units capable of supplying up to 100 percent outdoor air and providing heating and ventilating only.

1.3 DEFINITIONS

   A. BAS: Building automation system.

1.4 PERFORMANCE REQUIREMENTS

   A. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
      1. The term "withstand" means "the unit will remain in place will remain in place without separation of any parts from the device when subjected to seismic forces specified."

1.5 ACTION SUBMITTALS

   A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and 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.
      3. Prepare the following by or under the supervision of a qualified professional engineer:
         a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
         b. Include diagrams for power, signal, and control wiring.
1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-curb mounting 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. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

B. Startup service reports.

C. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set for each unit.

1.9 QUALITY ASSURANCE

A. Comply with NFPA 70

B. ETL or UL Labeling: List and label units by ETL or UL. Any unit delivered to site without such label, the manufacturer shall pay all costs to have ETL or UL field certification accomplished and the labels registered and field applied with a field certification report prepared by either agency.

C. ASHAE / IES 90.1 Compliance Applicable requirements in ASHRAE/IES 90.1, Section 6 “Heating, Ventilating, and Air-Conditioning.”

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Heat Exchangers: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck
2. Hastings HVAC
3. Titan
4. Captive Air

2.2 SYSTEM DESCRIPTION

A. Factory-assembled, prewired, self-contained unit consisting of cabinet; supply fan; controls; filters; motorized intake damper; evaporative cooling section and indirect gas-fired burner to be installed exterior to the building.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by ETL or UL, and marked for intended location and application.

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Double-wall insulated metal cabinet.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

B. Configuration:

1. Horizontal unit with discharge orientation: Bottom.
2. Support installation: Roof-mounting.

C. Outer Casing:

1. Material: 18-gauge (0.052-inch) galvanized steel (G90).

D. Inner Casing:

1. Material: 24-gauge (0.028-inch) solid (not perforated) galvanized steel (G90).

E. Insulation: Double-wall construction.
1. Between inner/outer Casing: 1-inch thick fiber glass blanket, comply with ASTM C 1071 Type I; 1.5 lb/cu. Ft. density.
2. Bottom: 1-inch thick rigid fiber glass board with lower surface integral aluminum foil faced; comply with ASTM C 1071 Type II; 1.5 lb/cu. Ft. density.

F. 1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling-unit sections, accessories, and components with reinforcement to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when air-handling-unit frame is anchored to building structure.

H. Inspection and Access Panels and Access Doors:
1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:
   a. Fasteners: Captive fasteners for panel lift-out operation.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Size: Large enough to allow inspection and maintenance of unit's internal components.
3. Access Doors:
   a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Size: Large enough to allow inspection and maintenance of unit's internal components.
4. Locations and Applications:
   a. Filter Section: Inspection and hinged access panels.
   b. Coil Section: Inspection and hinged access panel.
   c. Fan Section: Inspection and hinged access panels.
   d. Discharge Section: Inspection and hinged access panels.
   e. Damper Section: Inspection and hinged access panels.

2.4 HOT-WATER HEATING COIL

A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label.

B. Coil Casing Material:
   1. Manufacturer's standard material.
   2. Aluminum.

C. Tube Material: Copper.

D. Tube Header Material:
   1. Manufacturer's standard material.
   2. Copper.
E. Fin Material: **Aluminum**.

F. Fin and Tube Joints: Mechanical bond.

G. Leak Test: Coils shall be leak tested with air underwater.

2.5 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.

B. Materials: Match cabinet.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.6 ROOF CURBS

A. Roof curbs with vibration isolators and seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Curb Height: 24 inches high and full perimeter including evaporative section.

C. Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

2.7 SUPPLY-AIR FAN

A. Fan Type: Centrifugal, double width, double inlet forward curved wheel.

1. Dynamic Balance: Comply with AMCA Standard 204-05 (R2012), Fan Application Category BV-3; Balance Quality Grade 6.3.

2. Fan Performance: Certified in accordance with AMCA Standard 211-05;

3. Fan wheel and housing material: Galvanized steel (G90);


5. Bearings:

   a. Self-aligning permanently lubricated ball bearings.

   b. Bearing L-10 life rating according to ABMA 9: 150,000 hours.

B. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.

C. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Open dripproof.

2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
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.

2.8 AIR FILTERS

A. General Requirements for Air Filtration Section:
   1. UL listed and labeled: UL 900 in accordance with NFPA 90A.
   2. Provide minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   3. See Filter Schedule on Plans for filter configuration and maximum filter face velocity.

B. Pleated Panel Filters:
   1. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type disposable air filters with holding frames.
   2. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.
      a. Adhesive: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
      b. Media shall be coated with an antimicrobial agent.
      c. Separators shall be bonded to the media to maintain pleat configuration.
      d. Welded-wire grid shall be on downstream side to maintain pleat.
      e. Media shall be bonded to frame to prevent air bypass.
   3. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or boned to the media.
   4. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.
   5. Capacities and Characteristics:
      a. Thickness or Depth: 2-inches.
      b. MERV Rating: 8 when tested according to ASHRAE 52.2.

2.9 OUTDOOR-AIR DAMPERS

A. General Requirements: Low-leakage airfoil dampers bearing the AMCA Seal.

B. Aluminum, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals.

C. Air performance and air leakage: Based on tests and procedures performed in accordance with AMCA Publication 511. Damper shall be AMCA leakage Class 2, 10 cubic feet per minute at 1.0 inch w.g. pressure difference through a 48-inch by 48-inch damper. Maximum blade length shall be 48-inches.

D. Damper Operator: Direct coupled, electronic, two-positron with spring return as required by the control sequence.
2.10 REMOTE UNIT CONTROL PANEL

A. Factory-wired, fuse-protected control transformer, single point connection for power supply and field-wired unit to remote control panel.

B. Control Panel: Surface-mounted remote panel with engraved plastic cover and the following lights, switches and functions:

4. Heating operation indicating light.
5. Cooling operation indication light
6. Thermostat.
7. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
8. Safety-lockout indicating light.

2.11 CONTROLS

A. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.

B. Control Devices:

1. Remote Thermostat: Adjustable thermostat (in Remote Unit Control Panel) with temperature readout of supply air temperature.

C. Hot-Water Coil Controls: Factory-mounted sensor in unit discharge with sensor adjustment located in control panel to modulate factory-furnished coil control valve to maintain supply air temperature.

D. Outdoor-Air Damper Control: Outdoor-air damper shall open when supply fan starts, and close when fan stops.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Curb Support (curb provided by manufacturer): Install roof curb on roof structure according to "The NRCA Roofing Manual."
   1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
   2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
   3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

C. (Seismic) Restrained Curb Support: Install restrained vibration isolation roof-curb rails on roof structure according to "The NRCA Roofing Manual."

D. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."

E. Install separate devices furnished by manufacturer and not factory installed.

F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

A. Where installing piping adjacent to units, allow space for service and maintenance.

B. Hydronic Piping Connections:
   1. Comply with requirements in Section 23 2113 "Hydronic Piping" and Section 23 2116 Hydronic Piping Specialties."
   2. Install shutoff valve and union or flange on each supply connection and install balancing valve and union or flange on each return connection.

C. Duct Connections:
   1. Comply with requirements in Section 23 3113 "Metal Ducts."
   2. Drawings indicate the general arrangement of ducts.
   3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 23 3300 "Air Duct Accessories."

D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
   a. Heating coil leaving-air temperature.
   b. Cooling coil entering-air, dry- and wet-bulb temperatures.
   c. Condenser coil entering-air dry-bulb temperature.
   d. Condenser coil leaving-air dry-bulb temperature.

2. Simulate maximum heating demand and inspect the following:
   a. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.

3. Inspect casing insulation for integrity, moisture content, and adhesion.
4. Verify that clearances have been provided for servicing.
5. Verify that controls are connected and operable.
6. Verify that filters are installed.
7. Clean coils and inspect for construction debris.
8. Inspect and adjust vibration isolators and seismic restraints.
10. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
11. Adjust fan belts to proper alignment and tension.
12. Start unit.
13. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
14. Operate unit for run-in period.
15. Calibrate controls.
16. Inspect outdoor-air dampers for proper stroke.
17. Verify operational sequence of controls.
18. Measure and record the following airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.
3.5 ADJUSTING
   A. Adjust initial temperature set points.
   B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
   C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION
   A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 7433
SECCTION 23 8239.16 - PROPELLER UNIT HEATERS

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 propeller unit heaters with hot-water coils.

1.3 DEFINITIONS
A. BAS: Building automation system.
B. CWP: Cold working pressure.
C. PTFE: Polytetrafluoroethylene plastic.
D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include location and size of each field connection.
   4. Include details of anchorages and attachments to structure and to supported equipment.
   5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
   6. Indicate location and arrangement of piping valves and specialties.
1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which propeller unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. **Manufacturers**: Subject to compliance with requirements, provide products by one of the following:

1. Airtherm.
2. McQuay International; Daikin Industries.
4. Rittling
5. Trane.

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in vertical and horizontal discharge configuration with adjustable discharge louvers.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2.3 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.4 COILS

A. General Coil Requirements: Test and rate propeller unit-heater coils according to ASHRAE 33 in the following application:
   1. Hot-water.

B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

2.5 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, multispeed. Comply with requirements in Division 23 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

A. Control Devices:
   1. Thermostat:
      a. Wall-mounted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Division 23 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 "Vibration Controls for HVAC."

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," Division 23 "Steam and Condensate Heating Piping," and Division 23 “Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Division 23 "Hydronic Piping" and Division 23 Hydronic Piping Specialties."

E. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of propeller unit heater. Steam specialties are specified in Division 23 Steam and Condensate Piping Specialties." 

F. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 23 8239.16