

PROJECT MANUAL

FOR

**MOUND FORT JR HIGH SCHOOL
HVAC REPLACEMENT PROJECT**

**1396 Liberty Ave
Ogden, Utah - 84404**

RFP 23-020

February – 2023

**OGDEN SCHOOL DISTRICT
1950 Monroe Blvd
Ogden Utah 84401**

PREPARED BY:

**OLSEN & PETERSON CONSULTING ENGINEERS, INC.
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HVAC REPLACEMENT PROJECT**

February 2023

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**Mound Fort Jr High School HVAC Replacement Project
Ogden School District
1950 Monroe Blvd
Ogden UT, 84401**

RFP 23-020

**Project Date: May 1st, 2023 - October 9th, 2023
Bid Due: March 6th, 2023 @ 2:00pm**

Project:

**Mound Fort Junior High School
1396 Liberty Avenue
Ogden UT, 84404**

NOTICE TO BIDDERS

Electronic bids will be received by the Board of Education of the Ogden School District, for the Mound Fort Junior High HVAC Replacement Project. Bids will be in accordance with these specifications. **This project is Federally funded, (American made products preferred, and Prevailing Wages /Davis Bacon shall apply.)**

A Pre-bid walk through will be held Tuesday February 21, 2023 at Mound Fort Junior High School in Ogden, Utah at 10:00 am. **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 2:00 pm March 6, 2023. **Bids must be submitted on Sciquest.com**

A bid bond (image of the bid bond uploaded in SciQuest) in the amount of (5%) of the bid, made payable to the Board of Education of the Ogden School District, shall accompany the 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 the 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 of the District.

If bidders have questions or need to seek clarification during this bidding process, then questions must be received in writing through Sciquest no later than March 1, 2023 at 12:00pm.

BOARD OF EDUCATION OF THE OGDEN SCHOOL DISTRICT
KEN CRAWFORD, DIRECTOR OF SUPPORT SERVICES



BID FORM RFP 23-020

Name of Bidder _____ Date _____

Address of Bidder _____

To the Board of Education of the Ogden City School District

1950 Monroe Blvd Ogden, UT 84401

RFP23-020 Project Dates: May 1st 2023 - October 9th 2023

The undersigned, in compliance with your invitation for bids for the Mound Fort Junior High 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 _____

#3 _____ Date _____

Base Bid Project: This base bid shall include all work in the construction documents for RFP 23-020 Mound Fort Junior High HVAC Replacement Project . I/We agree to perform this work for the sum of: _____ Dollars (\$ _____)

(In case of discrepancy, written amount shall govern)



BID BOND

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 Company _____

Authorized Signature _____

Printed 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 (42USC 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.

Revision date: November 6, 2017

SECTION 03 1000 - CONCRETE FORMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Furnish and install required formwork ready for placing of concrete.
 - 2. Strip and dispose of formwork.

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. Forms: Wood, metal, or plastic as arranged by Contractor. Forming material shall be compatible with specified form release agents and with finish requirements for concrete to be left exposed or to receive decorative finish.
- B. Expansion / Contraction Joints:
 - 1. 1/2 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Forms:
 - 1. Assemble forms so forms are sufficiently tight to prevent leakage. Properly brace and tie forms. Make proper form adjustments before, during, and after concreting.
 - 2. Use new forms, or used forms that have been cleaned of loose concrete and other debris from previous concreting and repaired to proper condition. Provide smooth liner on forms used for concrete to be exposed if necessary to attain specified finish quality.
- B. Accessories:
 - 1. Provide for installation of inserts, templates, fastening devices, and other accessories to be set in concrete before placing.
 - 2. Position anchor bolts for hold-down anchors and securely tie in place prior to placing concrete.
- C. Expansion Joints: Install at joints between slab and sidewalks.

END OF SECTION 03 1000

SECTION 03 2000 - REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:

1. Furnish and install epoxy coated rebar and welded wire fabric for all concrete slabs and equipment supports.

1.2 REFERENCES

A. American Society For Testing And Materials:

1. ASTM A 185-02, 'Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete.'

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing:

1. Flat sheets of welded steel wire fabric for concrete reinforcement of interior equipment pads meeting requirements of ASTM A 185. Style: 6 x 6 - W1.4 x W1.4.
2. Epoxy-coated reinforcing bars fabricated according to ASTM A775 or ASTM A934 for exterior chiller slab.

B. Reinforcing Supports:

1. Acceptable Product:
 - a. Concrete 'dobies' or blocks wired to reinforcing.
 - b. Manufactured chairs with 4 sq in bearing surface with sub-grade, or other feature to prevent chair from being pushed into sub-grade.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install epoxy coated re-bar for exterior concrete support slab as indicated. Concrete slab to be 6 inch minimum depth.
- B. Tie wire mesh together 24 inches on center minimum with 6 inch overlap.
- C. Support wire mesh sheets at 24 inches on center along edges and 24 inches on center minimum each way in field with reinforcing supports to maintain mesh in center of slab.

END OF SECTION 03 2000

SECTION 03313 - STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Furnish and install Project concrete slab work as described in Contract Documents.
 - 2. Furnish and install concrete slab for new air cooled chiller.
 - 3. Furnish and install new concrete infill for existing condensate feed tank.
 - 4. Furnish and install new concrete service slabs for all pumps, boilers, heat exchangers, expansion tanks and elsewhere as indicated.
 - 5. Furnish and install replacement sidewalk slabs where indicated.
- B. Products Installed but Not Supplied Under This Section:
 - 1. Inserts, bolts, boxes, templates, and fastening devices for other work, including those for bases only for Mechanical and Electrical.

1.2 SYSTEM DESCRIPTION

- A. Performance Requirements:
 - 1. Conform to requirements of ASTM C 94 unless specified otherwise.

1.3 PROJECT CONDITIONS

- A. Project Environmental Requirements:
 - 1. Hot Weather Concreting Procedures:
 - a. Maximum concrete temperature allowed is 90 deg F in hot weather.
 - b. Cool aggregate and subgrades by sprinkling.
 - c. Avoid cement over 140 deg F.
 - d. Use cold mixing water or ice.
 - e. Use fog spray or evaporation retardant to lessen rapid evaporation from concrete surface.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: Meet requirements of ASTM C 150, Type 2
- B. Reinforcement: Epoxy coated rebar where indicated for air cooled chiller slab and boiler slabs. Size rebar as indicated.
- C. Aggregates:
 - 1. Coarse:
 - a. Meet requirements of ASTM C 33 or nonconforming aggregate that by test or actual service produces concrete of required strength and conforms to local governing codes.
 - b. Aggregate shall be uniformly graded.
 - c. Water: Clear, apparently clean, and potable.
- D. Admixtures And Miscellaneous:
 - 1. Mineral:

- a. Fly Ash Pozzolan: Meet requirements of ASTM C 618, Class F or C and with loss on ignition (LOI) of 3 percent maximum.

2.2 MIXES

- A. Mix designs to meet following requirements:
 1. Proportions:
 - a. Mix Type 2:
 - 1) Minimum weight cement per cu yd concrete: 564 lbs.
 - 2) Water / Cement Ratio: 0.45 maximum by weight.
 - b. Air Entrainment:
 - 1) Exterior Concrete: 6 percent, plus or minus 1-1/2 percent.
 - c. Do not add water any time during mixing cycle above amount required to meet specified water / cement ratio. No reduction in the amount of cementitious material is allowed.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Furnish and install concrete slabs for each mechanical piece of equipment including air cooled chiller, boilers, pumps, heat exchangers and expansion tanks.
- B. Inserts, bolts, boxes, templates, pipes, conduits, and other accessories required shall be installed and inspected before placing concrete.

3.2 INSTALLATION

- A. Site Tolerances:
 1. Tolerances shall conform to requirements of ACI 117, except where specified differently.
 2. Local Flatness / Levelness of exterior Slabs:
 - a. Specified Overall Value of F_F28 / F_L20 and Minimum Local Value of F_F20 / F_L15 when tested in accordance with ASTM E 1155.
 3. Place as soon after mixing as possible. Deposit as nearly as possible in final position. Placing of concrete shall be continuous until a panel or section is complete. Compact concrete in forms by vibrating and other means where required. Thoroughly work in concrete around reinforcing bars..
 4. Joints:
 - a. Construction Joints: Locate to least impair strength of completed structure.
- B. Bonding Fresh And Hardened Concrete:
 1. Re-tighten forms.
 2. Roughen surfaces.
 3. Clean off foreign matter and laitance.
 4. Wet but do not saturate.
 5. Proceed with placing new concrete.
- C. Special Requirements:
 1. Equipment Bases: Coordinate with appropriate Sections for locations and dimensions.
 2. Anchor Bolts: Place anchor bolts not tied to reinforcing steel immediately following leveling of concrete. Reconsolidate concrete around bolt immediately after placing bolt. Do not disturb bolts during finishing process.
- D. Finishing:
 1. Broom Finishes, Exterior Flatwork
 - a. Broom finish exterior slabs.
 - b. Round edges including edges formed by expansion joints.

- c. Remove edger marks.
- E. Curing:
 - 1. All Other Concrete Flatwork: Membrane cure.

3.3 PROTECTION

- A. Protect concrete that has not received its initial set from precipitation to avoid excess water in mix and unsatisfactory surface finish.
- B. Do not allow materials resulting from construction activities, which will affect concrete or application of finish floor systems adversely, to come in contact with interior concrete slabs.

END OF SECTION 03 3000

SECTION 03 4000 - CHAIN LINK FENCES

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Install new commercial grade, chain link fence complete with anti-scaling feature and (2) 4'-0" wide lockable gates with center locking post and sleeved foundation pole insert as described in Contract Documents.
 - 2. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has at least three years' experience and has completed at least five chain link fence projects with same material and of similar scope to that indicated for this Project with a successful construction record of in-service performance.

1.3 FIELD MEASUREMENTS:

- A. Verify layout information for fences shown on the Drawings in relation to the property survey and existing structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Post Setting Grout at Sleeves:
 - 1. Commercial nonshrink grout conforming to requirements of ASTM C 1107, Type B or C.
 - a. Equal as approved by Architect before use.

2.2 COMPONENTS

- A. Fabric:
 - 1. Chain link fabric of 6 ga wire fabric with fabric ties, galvanized before or after weaving with 1.2 ounce zinc coating conforming to requirements of ASTM A 392, Class I
 - 2. 2 inch square mesh. Coating: ASTM A 817, Type 2, Class 2, zinc-coated (galvanized).
 - 3. Knuckle both selvages.
- B. Framework:
 - a. Corner and Line Posts: Commercial grade, heavy duty 3" dia, galvanized steel. Schedule 40 steel tubular, section 5.79 lbs/lin ft meeting requirements of ASTM F 1083.
 - b. Rails: Top, Bottom and Intermediate rails, heavy duty, 2-1/2" dia, galvanized steel Schedule 40 tubular steel, with 2 ounce zinc coating per sq ft of surface area conforming to ASTM A 123.
 - c. Fittings: Pressed steel or malleable iron, hot-dip galvanized conforming to ASTM A 153. Tie wires shall be 12 ga minimum galvanized steel or 9 ga minimum aluminum wire.
 - d. Tension Wire: 7 ga minimum galvanized spring steel.

2.3 MIXES

- A. Post Foundation Concrete:
1. One cu ft cement, 2 cu ft sand, 4 cu ft gravel, and 5 gallons minimum to 6 gallons maximum water.
 2. Mix thoroughly before placing.

2.4 GATES

- A. Fence gates shall be constructed in similar fashion to the fence and shall consist of two 4'-0" hinged gates with center locking post, hasp and pad lock.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install heavy duty, commercial grade fence posts, rails and fence fabric as indicated. Fence shall be installed by mechanics skilled and experienced in erecting fences of this type and in accordance with Contract Documents. General: Install fence to comply with ASTM F 567. Do not begin installation and erection before final grading is completed, and mechanical equipment is in place unless otherwise permitted
1. Evenly space posts in line of fence a maximum of 8 feet center to center.
 2. Vertical fence shall be 8'-0" tall not including anti-climb fence. Overall fence height shall be approximately 10'-0"
 3. Anti – climb fence shall be angled at 45 degrees to prevent scaling of fence and extend outward and away from the vertical fence at least 24"
- B. Post Foundations:
1. Set posts with concrete post foundations as specified below:
 - a. Corner and Line Posts Diameter 12 inches Depth 36 inches
- C. Fence:
1. After posts have been permanently positioned and concrete cured for one week minimum, install framework, braces, and rails. Join rails with 6 inch minimum couplings.
 2. Stretch fabric by attaching one end to terminal post and supplying sufficient tension to other end of stretch so slack is removed.
 - a. Fasten fabric to line posts with tie wires. Pass ties over one strand of fabric and hook under line post flange.
 - b. Install center rails in one piece between posts and flush with post on fabric side, using rail ends and special offset fittings where necessary.
 - c. Place one tie as close to bottom of fabric as is possible with additional ties equally spaced between top and bottom band on approximately equal spacing not to exceed 14 inches on center.
 - d. Attach fabric to roll formed terminals by weaving fabric into integral lock loops formed in post. Attach fabric to tubular terminals with tension bars and bands.
 - e. On top rail, space tie wires at no more than 24 inches on center.
 - f. Securely attach fittings and firmly tighten nuts.
- D. Provide anti-climb section of fence as indicated. Angle vertical rails and fabric outward at 45 deg to prevent fence scaling. Provide additional rails and supports as needed.

END OF SECTION 03 4000

SECTION 22 1116 - WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Water make up lines to boilers, glycol feed tanks and equipment.
- B. Relocated cold water piping systems.
- C. Connections to existing make up water piping systems.

1.2 QUALITY ASSURANCE

- A. Comply with NSF 61 for non-potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper with wrought-copper solder-joint fittings.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of water piping. Install piping as indicated unless deviations to layout are approved.
- B. Install bronze ball type shutoff valves immediately upstream of each piece of equipment or where indicated.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise. Install piping adjacent to equipment and specialties to allow service and maintenance. Install piping to permit valve servicing.
- D. Install piping free of sags and bends. Install fittings for changes in direction and branch connections. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty

3.2 EQUIPMENT INSTALLATION

- A. Remove and relocate the existing make up water lines serving the existing boiler system. Remove and relocate as needed to provide new make up water piping system to new boilers and new glycol feed tank.
- B. Provide new ball valves at points of connection.

3.3 VALVE INSTALLATION

- A. Install shutoff valve close to equipment, on each water supply to equipment using ball or gate valves for piping NPS 2 and smaller.
- B. Provide zone valves at each branch connection.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

END OF SECTION 22 1116

SECTION 22 1316 - DRAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes condensate drainage piping inside the building:

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 - 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought-copper, solder-joint fittings.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Install copper drainage piping with soldered joints at 1 percent downward slope in direction of flow. Install boiler full size of boiler connections. Install other drain lines including expansion tank drain lines, air separator and drain lines serving high points in the hydronic piping system. Extend piping to nearest available floor drain, trench drain or drain body. Anchor piping to floor structure using c-channel pipe supports and pipe clamps. Anchor channel to concrete flooring. Terminate drain piping with 45 or 90 degree downturn elbow at drain body.
- B. Pipe air vent drains as indicated. Terminate air vent drains with ball valve and threaded hose connection.

END OF SECTION 22 1316

SECTION 23 0200 – MECHANICAL DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Demolition, removal, salvage and disposal of existing mechanical equipment and materials.
Specifically:
 - a. Steam Boilers
 - b. Steam Condensate Pumps and Tank
 - c. Steam and Condensate Piping
 - d. Steam Coils
 - e. Pumps
 - f. Hydronic Piping
 - g. Pneumatic Valves and Controls
 - h. Evaporative Coolers
 - i. Ductwork
 - j. Controls
 - k. Misc Items

1.2 DEFINITIONS

- A. Demolish or Remove: Items designated to be demolished or removed are to be removed complete, transported off site and legally disposed of. Includes the removal of designated mechanical equipment, piping, ductwork and their appurtenances.
- B. Existing to Remain: Mechanical equipment or items indicated to remain shall be protected against damage during demolition operations.

1.3 MATERIALS OWNERSHIP

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

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with governing notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

- A. Areas of work and mechanical systems to be demolished will be vacated and their use discontinued before start of the Work. Notify owner 72 hours in advance of demolition activities that will affect operations of adjacent occupied spaces.
- B. Areas of the building immediately adjacent to demolition areas may be occupied. Coordinate with building owner to limit transmittance of dust and noise during demolition operations. Conduct building demolition so operations of occupied areas will not be disrupted.

- C. Cover and protect walls, floors, systems furniture and electronics during demolition operations. Restore spaces to original condition after demolition and general construction work is completed.

1.6 EXISTING CONDITIONS

- A. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials such as asbestos are encountered, do not disturb; stop work and immediately notify Architect and Owner. Hazardous materials will be removed by Owner under separate contract.
- B. On-site storage of removed items or materials is not permitted.
- C. Contractor shall visit site prior to bidding to become familiar with existing conditions and to ascertain and evaluate all items scheduled to be removed or requiring demolition. No extra payment for demolition work will be allowed for items or materials discovered during the course of demolition procedures.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide and erect temporary dust protection, dust barriers, plastic floor and wall sheathing, tarps and others devices, as required to protect building walls, floors, equipment and components from damage during demolition and construction activity.
- B. Where roof top equipment is removed, provide weather tight tarps or barriers to protect interior of building from inclement weather until roof opening is covered, patched and repaired.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that existing services and utilities have been disconnected and capped before starting demolition operations.

3.2 PREPARATION

- A. Review mechanical equipment to be removed with Engineer and Owner prior to commencing work.
- B. Where electrical service is disconnected provide temporary lighting of areas of construction.
- C. Disconnection and Service Interruptions: When existing mechanical or electrical systems are scheduled to be removed and this removal causes loss of operation of adjacent mechanical or electrical systems; provide temporary bypasses or alterations of mechanical and electrical system to retain operation of affected systems.
- D. Existing Services: Locate, identify, disconnect, and seal or cap off indicated heating hot water, gas, electrical service serving mechanical equipment to be demolished. Drain piping systems complete.

3.3 PROTECTION

- A. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
- B. Temporary Protection: Erect temporary dust protection sheathing, tarps and devices to protect, walls, floors, windows, equipment and components and other adjacent construction that are to remain and that are exposed to building demolition and construction operations.
- C. Remove temporary barriers and protections where hazards no longer exist.

3.4 DEMOLITION, GENERAL

- A. Drawings: Demolition drawings are diagrammatic and do not indicate in detail the full extent of mechanical demolition work required. Prior to bidding, contractor shall visit project site to determine full extent of required mechanical demolition work and shall include costs for such work in his bid.
- B. General: Demolish indicated existing mechanical equipment and associated appurtenances completely. :
 - 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 - 2. Maintain fire watch during and flame cutting operations.
 - 3. Remove demolished equipment, debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 4. Where required remove concrete equipment pads complete. Leave floor in a clean and orderly fashion.
 - 5. Remove all abandoned pipe supports in mechanical rooms.
 - 6. Remove any mechanical or electrical item that is non-functional or abandoned in the boiler or mechanical rooms. This includes all equipment, piping, supports and controls.
- C. Drain the heating hot water system in its entirety or as needed to facilitate the mechanical construction work required.
- D. Remove connected piping systems back to a convenient location and cap.
- E. Mechanical contractor is responsible for removal of demolition items on the drawings which do not contain asbestos including, boilers, condensate feed tanks, mechanical pumps, piping, controls expansion tanks and other miscellaneous items.
- F. Remove debris from the building by means and methods that will convey debris to grade level in a manner to minimize noise, ground impact and dust generation.
- G. Abandonment: Abandonment of piping in utility tunnels is permitted where indicated on the drawings. Abandonment of demolished mechanical equipment, ductwork or piping above accessible ceiling systems or in mechanical spaces is prohibited. Remove all accessible and un-used mechanical equipment, ductwork and piping systems that is not re-used as part of the new work.
- H. Pipe Caps and Flanges: Active or continued piping systems that are disconnected, from mechanical systems to be demolished, shall be capped or flanged with same or similar piping material.
- I. Mechanical Equipment Demolition: Remove mechanical equipment scheduled for demolition. Where possible, remove mechanical equipment in whole. Where mechanical equipment cannot be removed in whole, disassemble mechanical joints or employ cutting procedures to cut and section mechanical equipment into suitably sized pieces for removal and transport.
- J. Remove mechanical systems complete including all associated piping and ductwork systems, insulation systems, equipment and piping supports, controls and both line and low voltage electrical systems.

3.5 REPAIRS

- A. Promptly repair damage to adjacent mechanical systems caused by demolition operations.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill.

3.7 CLEANING

- A. Upon completion of all demolition and construction activities, remove and dispose of all temporary dust barriers. Clean spaces and improvements of dust, dirt, and debris caused by mechanical demolition and construction operations. Return adjacent areas to condition existing before mechanical demolition operations began.

END OF SECTION 23 0200

SECTION 23 0500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Supports and anchorages.

1.2 SUBMITTALS

- A. Welding certificates.

1.3 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.

PART 2 - PRODUCTS

2.1 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.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

- C. Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Garlock Gaskets. No Exceptions
- C. Dielectric Unions: Factory-fabricated with Garlock Gaskets, union assembly with for 250-psig minimum working pressure at 180 deg F .
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures. Garlock Gaskets. No Exceptions
- 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: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F

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 in locations indicated.
- 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. 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.
- M. Verify final equipment locations for roughing-in.
- N. 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.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- 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. 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 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 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 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.

END OF SECTION 23 0500

SECTION 23 0513 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 STANDARDS AND QUALIFICATIONS:

- A. Furnish and install the VFD's noted on the drawings for the building system Heating Hot Water and Chilled Water Pumps. VFDs and options shall be UL508 listed as a complete assembly.
- B. The entire VFD assemblies, shall be seismically certified and labeled as such in accordance with the 2018 International Building Code (IBC).
- C. Acceptable Manufacturers: ABB, Yaskawa, Toshiba

1.2 SUBMITTALS

- A. Submittals shall include the following information:
 - 1. Outline dimensions, conduit entry locations and weight.
 - 2. Connection and power wiring diagrams.
 - 3. Complete technical product description including a complete list of options provided.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES (VFD's)

- A. The VFD's shall be selected and matched for the Heating Hot Water or Chilled Water Pump characteristics and properties indicated on the drawings. The VFD shall be enclosed in a UL type enclosure assembled and tested by the manufacturer.
- B. The VFD shall provide full rated HP output from a line of $\pm 10\%$ of nominal voltage. The VFD shall continue to operate without faulting from a line of +30% to -35% of nominal voltage.
- C. VFD's shall be capable of continuous full load operation under normal environmental operating conditions.
- D. VFD's shall include the following:
 - 1. Digital display, and keypad, Hand-Off-Auto selections and manual speed control. time clock, non-volatile memory, pre-programmed application macros for start up, custom setting capability, cooling fans, ramp programming to accelerate or decelerate to set point without tripping, adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps, ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip.
 - 2. The overload rating of the drive shall be 110% of its normal duty current rating.

3. The VFD shall include a coordinated AC transient surge protection system.
programmable loss-of-load (broken belt / broken coupling) Form-C relay output.
 4. Fault display, warnings and prompts.
 5. Critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
 6. Two (2) PID Set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD.
- E. VFD outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.
- F. Programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.
- G. Programmable, digital relay outputs. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. Programmable preset speeds. The VFD control shall include programmable preset speeds.
- H. The Keypad shall include a backlit LCD display with programming and fault diagnostics and assistants for Start-up, PID programming, set points and options, maintenance and troubleshooting.
- I. Display shall be in English (alpha-numeric codes are not acceptable):
- J. BACnet IP Connection: The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps.
- K. The VFD / bypass shall allow the BAS to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function. The VFD shall include an independent PID loop for customer use. The independent PID loop shall be used for boiler bypass valve control.
- L. Door interlocked Disconnect Switch with Fuses - Door interlocked, padlockable disconnect switch that will disconnect all input power from the drive and all internally mounted options.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation and procurement of the VFD's shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.
- B. Power wiring shall be completed by the electrical contractor and wiring requirements based on the VFD input current. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.
- C. Power wiring and conduit by the electrical contractor shall be complete to the VFD and from the VFD to the pumps.

- D. Control wiring and conduit by the controls contractor shall be complete to the pump control sensors, to the VFD's and from the VFD's to the pumps for a complete and functional heating hot water pump control system.

3.2 START-UP

- A. Factory start-up shall be provided for each drive by a factory authorized service center.

3.3 SEQUENCE OF OPERATION

- A. Coordinate the following with Specification Section 23 0900: Heating hot water pumps (P-1) and (P-2) are enabled and controlled through the DDC system. when OAT is less than 60 Deg F. (adjustable). Heating hot water pumps shall be monitored and controlled by the DDC system to maintain required minimum flow through the boilers.
- B. Pumps (P-1) and (P-2) shall operate in sequence during the OCCUPIED and WARM-UP modes and are each rated at 100% of the building load.
- C. During the OCCUPIED or WARM-UP modes, if the outside temperature is below 60 degrees F., the first sequenced boiler (B-1) isolation valve will open and the associated pump (P-1) will start. When minimum water flow through a boiler is detected by a paddle-type water flow switch located in the boiler, the boiler control system shall be enabled.
- D. VFD controllers on the pumps operating through a static pressure sensor located inside of the boiler room or 2/3 of the way down the existing hydronic piping system, shall vary the flow rate to the buildings fan coils, VAV terminals and other devices.
- E. The static pressure sensor shall also control the operation of the 2-way diverter valve in the boiler room to ensure adequate minimum water flow through the operating boiler.
- F. If a hot water pump or boiler does not start when commanded to do so by the DDC system, the other hot water pump and boiler shall automatically start & an alarm shall be sent to the DDC system.

3.4 TRAINING

- A. Training shall include installation, programming and operation of the VFD, bypass and serial communication. Factory authorized start up and owner training to be provided locally upon request.

3.5 WARRANTY

- A. The VFD Product Warranty shall be 36 months from the date of factory shipment. The warranty shall include all parts, labor, travel time and expenses. A toll free 24/365 technical support line shall be available.

END OF SECTION 23 0513

SECTION 23 0519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Thermometers.
 2. Gages.
 3. Flowmeters.

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Palmer - Wahl Instruments Inc.
 2. Trerice, H. O. Co.
 3. Weiss Instruments, Inc.
 4. Miljoco Corp.
 5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Thermometer: Die-cast aluminum, 9 inches long, magnifying glass face lens, red or blue reading, mercury or organic-liquid filled, satin-faced, non-reflective aluminum with permanently etched scale markings. Adjustable rotational connector with brass thermowell of length to suit installation. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range. Range: 30-240 deg F

2.2 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Palmer - Wahl Instruments Inc.
 2. Trerice, H. O. Co.
 3. Weiss Instruments, Inc.
 4. Miljoco Corp.
 5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100. Liquid-filled type, cast aluminum housing with glass face, bourdon tube operation, brass, NPS 1/4 bottom-outlet, satin-faced, non-reflective aluminum dial with permanently etched markings, red or dark color pointer, stainless steel ring. Accuracy: Plus or minus 2 percent range for fluids under pressure. Range: Two times operating pressure.

2.3 VENTURI FLOWMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Badger Meter, Inc.; Industrial Div.
 - 3. Flow Design, Inc.
 - 4. Victaulic Co. of America.
- B. Description: Differential-pressure design for installation in piping; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.
- C. Construction: Bronze, brass, or factory-primed steel; with brass fittings and attached tag with flow conversion data. 250 psig pressure rating, 250 deg F temperature rating, threaded or flanged end connections. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install liquid-in-glass thermometers at inlet and outlet of each boiler, chiller and heat exchanger and where indicated on the drawings.

3.2 PRESSURE GAGE APPLICATIONS

- A. Install pressure gages at suction and discharge of each hydronic pump and where indicated on the drawings.
- B. Install pressure gages at inlet of supply piping at the inlet and outlet of the heat exchanger.

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions. Install thermometers in piping accessible for service.
- B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position. Install needle-valve and snubber fitting in piping for each pressure gage for fluids.
- D. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.
- E. Install flowmeter elements in accessible positions in piping systems where indicated.

3.4 ADJUSTING

- A. Calibrate meters according to manufacturer's written instructions, after installation.

- B. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION 23 0519

SECTION 23 0523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Iron, single-flange butterfly valves.
 - 3. Iron swing check valves.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures. Valve Sizes: Same as upstream piping unless otherwise indicated.
- B. Valve Actuator Types:
 - 1. Handwheel: For valves other than quarter-turn types.
 - 2. Handlever: For quarter-turn valves NPS 8 and smaller except plug valves.
- C. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: With extended neck.
- D. 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.
 - 3. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig
 - c. CWP Rating: 600 psig
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Stainless Steel.
 - j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. Tyco Valves & Controls; a unit of Tyco Flow Control.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - 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: Stainless Steel

2.4 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Powell Valves.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 CWP Rating: 200 psig
 - c. NPS 14 to NPS 24 , CWP Rating: 150 psig
 - d. Body Design: Clear or full waterway.

- e. Body Material: ASTM A 126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Locate valves for easy access and provide separate support where necessary. Install valves in horizontal piping with stem at or above center of pipe. Install valves in position to allow full stem movement.
- B. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.2 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.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or butterfly valves.
 - 2. Throttling Service: Ball or butterfly valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

3.4 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Bronze Angle Valves: Class 150, bronze nonmetallic disc.
 - 3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
 - 4. Bronze Swing Check Valves: Class 150 bronze nonmetallic disc.
 - 5. Bronze Gate Valves: Class 150, NRS bronze.
 - 6. Bronze Globe Valves: Class 150, bronze nonmetallic 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: 200 CWP, EPDM seat, stainless-steel disc.
 - 3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, stainless-steel disc.
 - 4. High-Performance Butterfly Valves: Class 150, single flange.
 - 5. Iron Swing Check Valves: Class 125 metal seats.
 - 6. Iron Gate Valves: Class 125 OS&Y.
 - 7. Iron Globe Valves: Class 125

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.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze nonmetallic disc.
4. Bronze Gate Valves: Class 150, NRS
5. Bronze Globe Valves: Class 150, bronze nonmetallic 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: 200 CWP, EPDM seat, stainless-steel disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, stainless-steel disc.
4. High-Performance Butterfly Valves: Class 150, single flange.
5. Iron Swing Check Valves: Class 125, metal seats.
6. Iron Gate Valves: Class 125 OS&Y.
7. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125

END OF SECTION 23 0523

SECTION 23 0529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Metal framing systems.
 - 3. Fastener systems.
 - 4. Equipment supports.

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems and system contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
- B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Globe Pipe Hanger Products, Inc.
3. Grinnell Corp.
4. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

2.2 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. GS Metals Corp.
3. Power-Strut Div.; Tyco International, Ltd.
4. Thomas & Betts Corporation.
5. Tolco Inc.
6. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

2.3 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.4 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified 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. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 6, if longer ends are required for riser clamps.

- F. 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-joint construction to attach to top flange of structural shape.
- G. 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.
- H. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- I. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete or masonry construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel 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 building structure.
- B. 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 above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. Install hangers and supports to allow controlled thermal 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 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.
- H. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

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

3.5 ADJUSTING

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

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780

END OF SECTION 23 0529

SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Laminated Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White
 - 3. Background Color: Black
 - 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.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated plus the Specification Section number and title where equipment is specified.

2.2 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 cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

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 including chillers, boilers, pumps and expansion tanks.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed and at all 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.
- B. Pipe Label Color Schedule:
 - 1. Gas Piping:
 - a. Background Color: Yellow
 - b. Letter Color: Black
 - 2. Heating Hot Water Piping:
 - a. Background Color: Green
 - b. Letter Color: Black
 - 3. Chilled Water Piping:
 - a. Background Color: Green
 - b. Letter Color: Black
 - 4. Boiler Make Up Piping:
 - a. Background Color: Green
 - b. Letter Color: Black

END OF SECTION 23 0553

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. The mechanical contractor shall employ an independent technical firm to perform the checking, adjusting, and balancing (CAB) of the HVAC systems. Specifically the HVAC systems including air supply, return and exhaust systems and the Hydronic systems including heating hot water and chilled water supply and return systems. This firm shall be one whose operations are limited to the field of professional CAB, and this firm shall meet the following qualifications:

1. The firm shall be a member of AABC and/or NEBB.
2. The firm shall be one which is organized to provide professional services of this type.

B. **SYSTEMS**

1. Air Systems:

- a. Constant volume air systems- Multizone and Single Zone Systems
- b. Exhaust Air Systems

2. Hydronic Water Systems:

- a. Chilled Water Systems
- b. Heating Hot Water Systems

1.2 SUBMITTALS

- A. Certified CAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by CAB firm.
- B. Warranties specified in this Section.

1.3 CAB PERSONNEL

- A. All personnel used on the job site shall be engineering technicians, who shall have been permanent, full-time employees of the firm for a minimum of six (6) months prior to the start of the work for this project.
- B. As a part of this contract, the mechanical contractor shall make all changes in the sheaves, belts, and dampers, including the addition of dampers required for correct balance as required by the CAB firm, at no additional cost to the Owner.
- C. The mechanical contractor shall provide and coordinate services of qualified, responsible subcontractors, suppliers, and personnel as required to correct, repair, or replace any and all deficient items or conditions found during the testing, adjusting, and balancing period.

- D. In order that all systems may be properly checked, balanced, and adjusted as required by these specifications, the mechanical contractor shall operate said systems at his expense for the length of the time necessary to properly verify their completion and readiness for the CAB and shall further pay all costs of operation during the CAB period.
- E. The project completion schedule shall be coordinated with the CAB work to provide sufficient times to permit the completion of CAB services prior to Owner occupancy.

1.4 SERVICES OF MECHANICAL CONTRACTOR

- A. The mechanical contractor shall have all systems completed, functional, calibrated, and in operational readiness prior to notifying the CAB firm that the project is ready for their services. The mechanical contractor shall coordinate system readiness with the system commissioning contractor and shall certify in writing to the Owner's representative that the system is complete and ready to balance.
- B. Mechanical contractor shall ensure that all air filters are new and installed at each air moving device. The mechanical contractor shall ensure that all strainers, filters and other devices are clean and in working order prior to balancing.

1.5 SERVICES OF THE CAB FIRM

- A. The technical CAB firm shall submit biographical data on the individual proposed to directly supervise the CAB work. It shall also submit their record of specialized experience in the field of air and hydronic system balancing.
- B. Act as liaison between the Owner's representative and contractor and periodically inspect the installation of mechanical piping systems, sheet metal duct work, temperature controls and other component parts of the heating, air conditioning and ventilating systems as the installation progresses. The inspection will cover only those parts of the systems relating to the checking and balancing. The CAB contractor shall work closely with the mechanical contractor to ensure the proper placement and location of all air balancing dampers and water balancing control valves and balancing mechanisms.
- C. To check, adjust, and balance system components to obtain optimum conditions in each conditioned space in the building.
- D. Prepare and submit to the Owner's representative, complete reports on the balance and operations of the systems.
- E. The CAB firm shall be responsible for inspecting, adjusting, balancing, and logging the data on the performance of the following general systems, including all components.
 - 1. Heating hot water systems, chilled water systems including coils, controls, etc.
 - 2. HVAC systems including airflows at each register, grille or diffuser, Temperature control system in its entirety, includes the verification of all control sequences and safety devices.
- F. Before any adjustments are made, the air systems are to be checked for such items as dirty filter, duct leakage, damper leakage, equipment vibrations, correct damper operations, etc.
- G. Before any adjustments are made to water systems, the strainers shall be cleaned, temperature control valve operation shall be checked, pump rotation shall be checked, pressure reducing valves shall be adjusted, etc.
- H. It shall be the responsibility of the CAB personnel to check, adjust, and balance the components of the various systems as listed above using an applicable "proportionate balance procedure" in order that each of them will

operate under optimum noise, temperature and air flow conditions in the conditioned spaces in the building "while simultaneously operating at the most energy efficient condition."

- I. During the balancing process, if abnormalities or malfunctions of equipment or components are discovered by the CAB personnel, the owner's representative shall be advised promptly so that the condition may be corrected by the project contractor. Data from malfunctioning equipment or components shall not be recorded in the final CAB report.

1.6 QUALITY ASSURANCE

- A. CAB Firm Qualifications: Engage a CAB firm certified by AABC or NEBB Certification of CAB Reports: Certify CAB field data reports. This certification includes the following:
 1. Review field data reports to validate accuracy of data and to prepare certified CAB reports.
 2. Certify that CAB team complied with approved CAB plan and the procedures specified and referenced in this Specification.
- B. CAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the existing building during entire CAB period. Cooperate with Owner during CAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist CAB activities.
- B. Perform CAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.9 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee stating that AABC or NEBB will assist in completing requirements of the Contract Documents if CAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 1. The certified CAB firm has tested and balanced systems according to the Contract Documents.
 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS: (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper CAB of systems and equipment.
 - 1. Verify that balancing devices, such as water flow-control devices, balancing dampers and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. 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 air and hydronic systems and equipment controls.
- D. Examine equipment performance data including fan curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- F. Examine system and equipment test reports.
- G. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- H. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- J. Examine equipment for installation and for properly operating safety interlocks and controls.
- K. Examine automatic temperature system components to verify the following:
 - 1. Dampers, and other controlled devices are operated by the intended controller.
 - 2. Dampers are in the position indicated by the controller.
 - 3. Integrity of dampers for free and full operation and for tightness of fully closed and fully open positions.
 - 4. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 5. Sequence of operation for control modes is according to the Contract Documents.
 - 6. Interlocked systems are operating.
 - 7. Changeover from heating to cooling mode occurs according to indicated values.
- L. Report deficiencies discovered before and during performance of CAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and this Section.
 - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, fan-speed-control levers, and similar controls and devices, to show final settings.

3.3 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. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- C. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- D. Verify that motor starters are equipped with properly sized thermal protection.
- E. Check dampers for proper position to achieve desired airflow path.
- F. Check for airflow blockages.
- G. Check condensate drains for proper connections and functioning.
- H. Check for proper sealing of air-handling unit components.
- I. Check for proper sealing of air duct system.

3.4 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each 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.

3.5 PROCEDURES FOR AIR SYSTEMS

- A. Constant Volume Systems: After the fan systems have been adjusted, adjust the constant volume systems as follows:

1. Balance systems similar to other constant-volume air systems.
2. Set supply fan at full-airflow condition.
3. Adjust dampers.
4. Measure airflow for each multizone or single zone. Balance to CFM indicated.
5. Measure airflow at each supply air diffuser. Balance each diffuser (new and existing) to CFM indicated.
6. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
7. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.6 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 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 expansion tank liquid level.
 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.

3.7 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Set calibrated balancing valves, if installed, at calculated presettings.
- B. 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.
- C. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- D. 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.
- E. Measure the differential-pressure control valve settings existing at the conclusions of balancing.
- F. Examine strainers for clean screens and proper perforations.
- G. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- H. Examine heat-transfer equipment to ensure proper installation.
- I. Examine system pumps to ensure absence of entrained air in the suction piping.
- J. Examine equipment for installation and for properly operating safety interlocks and controls.
- K. Examine automatic temperature system components to verify the following:
1. Valves, and other controlled devices are operated by the intended controller.
 2. Valves are in the position indicated by the controller.
 3. Integrity of valves for free and full operation and for tightness of fully closed and fully open positions.
 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 5. Sensors are located to sense only the intended conditions.
 6. Sequence of operation for control modes is according to the Contract Documents.
 7. Controller set points are set at indicated values.
 8. Interlocked systems are operating.
 9. Changeover from heating to cooling mode occurs according to indicated values.
- L. 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.

3.8 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness 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. Isolating and balancing valves are open and control valves are operational.

3.9 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes

and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including valve position indicators, and similar controls and devices, to show final settings.

3.10 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 approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

3.11 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps.
 - 1. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
 - 1. Measure flow at all stations and adjust, where necessary Adjust balancing stations to within specified tolerances of indicated flow.. Record settings and mark balancing devices.

3.12 PROCEDURES FOR BOILERS

- A. If hydronic, measure entering- and leaving-water temperatures and water flow.

3.13 PROCEDURES FOR PUMPS

- A. Measure entering and leaving pressures across the pumps. Measure and report initial and final flowrates. Balance water flow using balance valves, triple duty valves, flow venturis etc to indicated capacity on the pump schedule.
- B. Measure and report motor amperages under full load conditions and ensure that motors are not overloaded.

3.14 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 - 2. If water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 - 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 - 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatt.
 - 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatt.
 - 6. Capacity: Calculate in tons of cooling.
 - 7. If air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.15 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Check main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.16 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Equipment with Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.

3.17 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of CAB firm.

3. Project name.
4. Project location.
5. Engineer's name and address.
6. Contractor's name and address.
7. Report date.
8. Signature of CAB firm who certifies the report.
9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
10. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
11. Nomenclature sheets for each item of equipment.
12. Data for terminal units, including manufacturer, type size, and fittings.
13. Hydronic Chilled Water and Heating Hot Water Data at each coil.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Other system operating conditions that affect performance.

- E. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of supply, return, and relief airflows.
2. Duct, outlet, and inlet sizes.
3. Position of balancing devices.

3.18 ADDITIONAL TESTS

- A. Within 90 days of completing CAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 23 0593

SECTION 23 0700 - INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removal and scrapping of all existing piping and equipment insulation systems within the confines of the boiler room and mechanical rooms; including but not limited to:
 - a. Steam Piping Systems
 - b. Condensate Piping Systems
 - c. Heating Hot Water Piping Systems
 - d. Equipment Jacketing and Insulation.
2. Installation of new piping, ductwork and equipment insulation within the confines of the boiler room and mechanical rooms and elsewhere as indicated; including but not limited to:
 - a. Chilled Water Piping Systems
 - b. Heating Hot Water Piping Systems
 - c. Equipment Jacketing and Insulation.
 - d. Exterior Hot Water Piping Systems
 - e. Exterior Chilled Water Piping Systems
 - f. Supply Air Metal Duct Systems- Newly Installed
3. Insulation Materials
 - a. Preformed pipe or equipment insulation consisting of high density Fiberglass or Mineral Fiber material with All Service Jacket (ASJ).
 - b. Unless specifically noted otherwise, insulation shall have composite fire and smoke hazard ratings (including insulation, jacket or facing, PVC covers, and adhesives), as tested by ASTM E84, NFPA 255 or UL 723 procedures, not exceeding a flame spread rating of 25 and smoke developed rating of 50.
 - c. Piping systems shall be insulated in accordance with the schedule below, including flanges, fittings, valves, expansion joints, vents, drains and similar appurtenances.
 - d. Exterior piping shall be insulated with a minimum of 2 inch insulation and jacketed with a 20 gage aluminum jacket sealed watertight.
 - e. Insulation shall be provided continuously through pipe saddles and sleeves.

B. Submittals

1. Submit manufacturers' information sheets for each piping and equipment system scheduled or indicated. Include information for insulating piping tees, elbows and fittings. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
2. Detail field application for each equipment type.
3. Furnish samples of insulation to be installed to Engineer for review.

1.2 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics:

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Mineral-Fiber, Preformed Pipe and Duct Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 Pipe Insulation.
 - c. Manson Insulation Inc.; Alley-K.
 - d. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. Comply with ASTM C 552, Type II, Class 2.

C. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. Ft or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less.

1. 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.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

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.

2.4 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Mon-Eco Industries, Inc.; 44-05.
 - c. Pittsburgh Corning Corporation; Pittseal 444.
 - d. Vimasco Corporation; 750.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 100 to plus 300 deg F .
 5. Color: White or gray.
 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D.
 7. Materials in first paragraph below are for sealing metal jacket seams and joints.
- 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.
- C. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F
 4. Color: Aluminum.
- D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F
 4. Color: White.
 5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 2.5 FACTORY-APPLIED JACKETS
- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
- 2.6 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.
1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White
 3. 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. Aluminum Jacket: Comply with ASTM B 209 Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - 1. Finish and thickness are indicated in field-applied jacket schedules.
 - 2. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper
 - 3. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper
 - 4. Factory-Fabricated Fitting Covers:
 - a. Same material, finish, and thickness as jacket.
 - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union covers.
 - e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

- D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290.

PART 3 - EXECUTION

3.1 DEMOLITION

- A. Remove existing piping insulation from all existing steam, condensate, heating hot water, and equipment jacketing systems. Remove piping insulation from all piping systems scheduled for demolition and from all piping systems designated to remain.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use de-mineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials on all new and existing piping systems, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

- B. 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. Install insulation with longitudinal seams at top and bottom of horizontal runs. Install multiple layers of insulation with longitudinal and end seams staggered. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

- C. Keep insulation materials dry during application and finishing. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer. Install insulation with least number of joints practical. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

- D. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- E. Install insulation with factory-applied jackets. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- F. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
 - 1. Extend jacket of outdoor insulation outside slab flashing and overlap slab flashing at least 2 inches

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. 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. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 6. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 7. 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.
 - 8. 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.
 - 9. 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.
 - 10. 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.
 - 11. 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.
 - 12. 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.
 - 13. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

14. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

B. Blanket Insulation Installation on Ducts: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.

- g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
 7. Stagger joints between insulation layers at least 3 inches
 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 CELLULAR-GLASS AND MINERAL FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with self sealing laps and with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.

- 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 cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch and seal joints with flashing sealant.

- C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below for all new and existing piping systems.

1. **Heating Hot Water:** Mineral -Fiber or Fiberglass preformed pipe insulation. Thickness: 2 inches
2. **Chilled Water:** Mineral -Fiber or Fiberglass preformed pipe insulation. Thickness: 2 inches
3. **Domestic Water:** Mineral -Fiber or Fiberglass preformed pipe insulation. Thickness: 1 inch.
4. **Heating Hot Water - Air Separator:** Mineral -Fiber or Fiberglass preformed sheets with ASJ for equipment insulation. Thickness: 2 inches
5. **Chilled Water - Air Separator:** Mineral -Fiber or Fiberglass preformed blankets or sheets with ASJ for equipment insulation. Thickness: 2 inches
6. **Heating Hot Water - Expansion Tank:** Mineral -Fiber or Fiberglass preformed blankets or sheets with ASJ for equipment insulation. Thickness: 2 inches
7. **Chilled Water - Expansion Tank:** Mineral -Fiber or Fiberglass preformed blankets or sheets with ASJ for equipment insulation. Thickness: 2 inches
8. **Hot Water / Hot Water - Heat Exchanger:** Mineral -Fiber or Fiberglass preformed blankets or sheets with ASJ for equipment insulation. Thickness: 2 inches

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed or exposed supply air and outdoor air. 2 inches thick

B. Items Not Insulated:

1. Fibrous-glass ducts.

END OF SECTION 23 0700

SECTION 23 1123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Pipes, tubes, and fittings.
 2. Piping specialties.
 3. Piping and tubing joining materials.
 4. Valves.
 5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 2. Service Regulators: 65 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressures: Two pressure ranges. Primary pressure is 5 psig and 2 psig and is reduced to secondary pressure of 0.5 psig or less.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 2. Operating-Pressure Rating: 0.5 psig
 3. End Fittings: Zinc-coated steel.
 4. Threaded Ends: Comply with ASME B1.20.1.
 5. Maximum Length: 36 inches

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.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. McDonald, A. Y. Mfg. Co.

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.
- B. Line Pressure Regulators: Comply with ANSI Z21.80.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Meter Company.
 - b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - c. Maxitrol Company.
 - d. Pietro Fiorentin
 - 2. Maximum Inlet Pressure: 5 psig
- C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Harper Wyman Co.
 - b. Maxitrol Company.
 - c. SCP, Inc.
 - 2. Body and Diaphragm Case: Die-cast aluminum.
 - 3. Springs: Zinc-plated steel; interchangeable.
 - 4. Diaphragm Plate: Zinc-plated steel.
 - 5. Seat Disc: Nitrile rubber.
 - 6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 - 7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
 - 8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
 - 9. Maximum Inlet Pressure: 2 psig

PART 3 - EXECUTION

3.1 INDOOR PIPING INSTALLATION

- A. Make connections to existing gas piping as indicated. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Extend new gas piping to new boilers as indicated. Make all required gas piping connections to new boilers per manufacturers instructions.
- C. Provide gas pressure regulators as each boiler connection.
- D. 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.
- E. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- F. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls.
- H. Locate valves for easy access and maintenance.
- I. Install fittings for changes in direction and branch connections.
- J. Install gas service pressure regulators where indicated on the drawings.
- K. Verify final equipment locations for roughing-in prior to installing gas piping.
- L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets.
- M. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- N. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- O. Connect branch piping to existing from top or side of horizontal piping.
- P. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.
- Q. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

3.2 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.3 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
 - 4. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Install hangers and roof supports for horizontal steel piping.
 - 1. Maximum span, 96 inches

3.5 CONNECTIONS

- A. Install piping adjacent to appliances to allow service and maintenance of appliances.
- B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 36 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.6 FIELD QUALITY CONTROL

- A. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

3.7 INDOOR PIPING SCHEDULE

- A. Aboveground, branch piping shall be the following:
 - 1. Steel 40 black steel pipe with malleable-iron fittings and threaded joints.

3.8 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at roof top unit connections shall be the following:
 - 1. Two-piece, full port, bronze ball valves with bronze trim.

END OF SECTION 23 1123

SECTION 23 2113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Chilled Water Piping
- B. Propylene Glycol: Upon completion of all heating hot water and chilled water piping systems the entire system shall be filled with an industrial grade Propylene Glycol/Water solution of 30% by volume with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems.

1.2 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding a minimum working pressure of 150 psig and temperature of 200 degrees F.
- B. All Heating Hot Water Piping and Chilled Water Piping 2-1/2" and larger shall be welded.

1.3 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping System
 - 2. Valves.
 - 3. Hydronic specialties.
 - 4. Pipe hangers and anchors
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L
- B. Wrought-Copper Fittings: ASME B16.22.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. S. P. Fittings; a division of Star Pipe Products.

C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: 2-1/2" and Larger. Schedule 40 ASTM A 53/A 53M, black steel with butt welded or socket welded fittings and ends.
- B. Steel Pipe: 2" and Smaller. Schedule 40 ASTM A 53/A 53M, black steel with threaded fittings and ends
- C. Steel Fittings: Welded on piping 2-1/2" and larger
- D. Malleable-Iron Threaded Fittings: 2" and smaller. ASME B16.3, Classes 150 and 300.
- E. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300

2.3 JOINING MATERIALS

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

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
 1. Factory-fabricated union assembly, for 150-psig minimum working pressure at 200 deg F

2.5 VALVES

- A. Gate, Globe, Check, Bronze, Calibrated-Orifice, Balancing Valves and Ball: Selected to suit system in which installed, with operating pressure and temperature. Valves shall be Brass or Ferrous Metal as required for system application, pressure and temperature rated for system. Threaded with wheel on single lever control. Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping." Manufacturers:
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."
- C. Subject to compliance with requirements, provide products by one of the following
 - a. Honeywell
 - b. Belimo

2.6 AIR CONTROL DEVICES

A. Manual Air Vents:

1. Bronze, Nonferrous, Screwdriver or thumbscrew suitable for pressure and temperature of system served. ½" size.

2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection. Threaded ends for 2 inch and smaller, perforated stainless steel basket with 50% free area. 125 psig rated.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Heating hot water and chilled water piping, aboveground, 2 inch and smaller. Use Type L drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
- B. Heating hot water and chilled water piping, aboveground, 2 inch and smaller. Schedule 40 steel pipe; Class 125 with cast iron or malleable iron fittings and threaded joints.
- C. Heating hot water and chilled water piping aboveground, 2-1/2 to 8 inch. Schedule 40 steel pipe; Class 125 with welded flange or socket welded fittings
- D. Air-Vent Piping:
 1. Inlet: Same as service according to the piping manufacturer's written instructions.

3.2 VALVE APPLICATIONS

- A. Install shut off-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install check valves as required to control flow direction.

3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated.
- B. Install piping in equipment rooms and service areas.
- C. Install piping in equipment rooms and service areas at right angles or parallel to building walls.
- D. Install piping to permit valve servicing.
- E. Install piping free of sags and bends. Install fittings for changes in direction and branch connections. Install piping to allow application of insulation. Select system components with pressure rating equal to or greater than system operating pressure.

- F. Install drains, consisting of a tee fitting, ball valve, and short threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- G. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- H. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- I. Install unions or flanges in piping adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- J. Install strainers on inlet side of each control valve, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers. Match size of strainer blow off connection.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports. Provide seismic restraints as required.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal and multiple horizontal piping with a maximum span of 7 feet for steel and 5 feet for copper between pipe hangers or supports. Verify actual supported loads for hanger sizes and spacing.

3.5 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- B. 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.
- C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping and elsewhere as required for system air venting.

3.7 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints uninsulated and exposed for examination during test.
 - 2. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 3. 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.

4. Fill system with required mixture of propylene glycol and water.

END OF SECTION 23 2113

SECTION 23 2116 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. The installation covers the furnishing and installing of heating hot water and chilled water specialties, etc., as specified and shown on drawings or as required to provide the complete heating hot water and chilled water systems shown on the drawings and specified herein.

PART 2 - PRODUCTS

- A. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 - 2. Ball: Brass or stainless steel.
 - 3. Plug: Resin.
 - 4. Seat: PTFE.
 - 5. End Connections: Threaded or socket.
 - 6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 7. Handle Style: Lever, with memory stop to retain set position.
 - 8. CWP Rating: Minimum 125 psig
 - 9. Maximum Operating Temperature: 250 deg F
- B. Diaphragm-Operated Safety Valves: ASME labeled.
 - 1. Body: Bronze or brass.
 - 2. Disc: Glass and carbon-filled PTFE.
 - 3. Seat: Brass.
 - 4. Stem Seals: EPDM O-rings.
 - 5. Diaphragm: EPT.
 - 6. Wetted, Internal Work Parts: Brass and rubber.
 - 7. Valve Seat and Stem: Noncorrosive.
 - 8. 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 SEPARATORS

- A. Type: Provide air separators of tangential type constructed of steel and tested and stamped in accordance with section 8 of the ASME Code for a working pressure of 125 psig.
- B. Provide separators on hydronic systems capable of separating not less than 80 percent of the entrained air on the first passage of water and not less than 30 percent of residual air on each subsequent passage through the separator.
- C. Provide flanged inlet and outlet connections, 3/4-inch diameter valve drain connection and 1-inch diameter top air eliminator connection.
- D. Provide 1-inch diameter pipe from the top air eliminator point to a 5 gallon, steel, ASME stamped 125 pound working pressure air receiver vessel with automatic float vent.
- E. Provide 1-inch diameter globe valve between the air separator and the air receiver.
- F. Air Separators shall be as manufactured by Bell & Gossett or Taco.

2.3 EXPANSION TANKS

- A. Furnish and install pre-pressurized diaphragm-type expansion tanks of sizes indicated on the drawings.
- B. Construct tanks of steel in accordance with section 8 of the ASME Code for a working pressure of 125 psig. Test and stamp tanks for the working pressure.
- C. Support tanks on 2-inch diameter steel pipe legs with cross bracing and floor plates anchored to the structure.
- D. Expansion Tanks shall be as manufactured by Bell & Gossett or Taco.

2.4 AIR-CONTROL DEVICES

- A. Manual Air Vents:
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Screwdriver or thumbscrew.
 - 4. Inlet Connection: NPS 1/2
 - 5. Discharge Connection: NPS 1/8
 - 6. CWP Rating: 150 psig
 - 7. Maximum Operating Temperature: 225 deg F
- B. Y-Pattern Strainers:
 - 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 (and larger).
 - 3. Strainer Screen: Stainless-steel, **20** mesh strainer, or perforated stainless-steel basket.
 - 4. CWP Rating: 125 psig

2.5 CONNECTORS

- A. Stainless-Steel Braided, Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 - 2. End Connections: Threaded or flanged to match equipment connected.
 - 3. Performance: Capable of 3/4-inch misalignment.
 - 4. CWP Rating: 150 psig
 - 5. Maximum Operating Temperature: 250 deg F

PART 3 - EXECUTION

3.1 COORDINATION

- A. All equipment and piping shall be arranged to allow for easy maintenance and access to service valves.
- B. Provide valves and unions or flanges at all pieces of equipment to allow maintenance.
- C. Install all automatic valves, sensor well, flow switches, etc., as directed by the control contractor.

3.2 INSTALLATION OF EXPANSION TANKS

- A. General: Install expansion tanks where indicated and in accordance with manufacturer's published installation instructions.

- B. Support: Install floor mounted tanks on minimum of 4-inch high concrete base. Provide anchor bolt inserts poured in place. Seismic brace tank to structure using cable braces or brackets.

3.3 INSTALLATION OF AIR SEPERATORS

- A. General: Install air separators where indicated and in accordance with manufacturer's published installation instructions.
- B. Support: Support air separators from overhead structure. Seismic brace seperator to structure using cable braces or brackets.

3.4 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 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.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.5 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

END OF SECTION 23 2116

SECTION 23 2123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Close-coupled, end-suction centrifugal pumps.

1.2 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
 - 3. Taco, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175 psig minimum working pressure and a continuous water temperature of 250 deg F
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tapings at inlet and outlet, and threaded companion-flange or flanged connections.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal: 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: Permanently lubricated ball bearings or thrust type
 - 6. Motor: Single speed, inverter duty rated where required with permanently grease-lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support.

Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

D. Capacities and Characteristics:

1. Capacity: See Drawings
2. Total Dynamic Head: See Drawings
3. Maximum Operating Pressure: 175 psig
4. Maximum Continuous Operating Temperature: 250 deg F
5. Inlet and Outlet Size: See Drawings
6. Motor Speed: 1750 RPM
7. Motor Horsepower: See Drawings
8. Electrical Characteristics: See Drawings

2.2 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast or ductile iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
- B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast or ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

- A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- C. Set base-mounted pumps on 4 inch high concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.2 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified by manufacturer. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install triple-duty valve and pressure gauge on discharge side of pumps.
- F. Install Y-type strainer, suction diffuser, pressure guage and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 2123

SECTION 23 2500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following HVAC water-treatment systems:
 - 1. HVAC glycol based water-treatment
 - 2. Provide glycol feed pump and associated tank as described in the contract documents.

1.2 PERFORMANCE REQUIREMENTS

- A. Closed hydronic systems, including hot-water heating, chilled water.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Glycol treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power and control wiring.
- C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of installing glycol fee equipment as specified in this Section.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 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.
 - 1. Capacity: 2 gal.
 - 2. Minimum Working Pressure: 125 psig

2.2 GLYCOL FEED EQUIPMENT

- A. Glycol Feed Tank and Pumps: Chilled Water System. As noted on the drawings. Provide 30% Glycol and Water Mixture for all chilled water systems and exterior heating hot water systems indicated.

- B. Glycol Feed Tank and Pump System:
 - 1. Microprocessor-based controller with LCD display
 - 2. Hand-off-auto switch for glycol pump.
 - 3. Illuminated legend to indicate feed when pump is activated.
 - 4. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
- C. Glycol Tanks:
 - 1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
 - 2. Molded cover with recess for mounting pump.
 - 3. Capacity: 50 gal.
- D. Glycol Injection Pumps:
 - 1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
 - 2. Adjustable flow rate.
 - 3. Metal and thermoplastic construction.
 - 4. Built-in relief valve.
 - 5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- E. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install glycol feed tank and pump system where indicated on the drawings. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install interconnecting control wiring for controls and sensors.
- C. Fill Chilled Water Piping Systems with **30% Propylene Glycol and Water Solution**
- D. Fill Heating Water Piping Systems exposed to ambient air (roof piping) with **30% Propylene Glycol and Water Solution**
- E. Interior heating hot water piping systems to be treated with chemical as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality required.
- F. Bypass Feeders: Install in closed hydronic systems and equipped with full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results for HVAC."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.
- F. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
- G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Verify Chilled and Heating Hot Water System specified are filled with 30% glycol water solution. Submit Test report to owner and engineer.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain glycol systems and equipment. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 2500

SECTION 23 2501 - CHILLED AND HEATING HOT WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following water-treatment systems:
 - 1. Closed Loop Chilled Water and Heating Hot Water-treatment chemicals and fill solutions.

1.2 PERFORMANCE REQUIREMENTS

- A. Water quality for Chilled Water and Heating Hot Water systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power and control wiring.
- C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- B. 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products and services by one of the following:
 - 1. West - Utah Inc
 - 2. Power Engineering Inc

2.2 SYSTEM VOLUMES

- A. The Water Treatment Contractor shall provide a water and 30% by volume propylene glycol solution for the entire buildings Chilled Water System and Roof Mounted Heating Hot Water System.
- B. Heating Hot Water System Interior: No Glycol Solution Required.
- C. The water treatment contractor shall include the costs for cleaning and flushing the new and existing chilled and heating hot water piping systems. Filling the Chilled Water and Heating Hot Water systems with a water and 30% by volume propylene glycol solution.
- D. The contractor shall accurately meter the amount of water-glycol solution added to each system and report total volumes for each system to the building owner.

2.3 AUTOMATIC GLYCOL-FEED EQUIPMENT

- A. Glycol Feed Tank and Pumps:
 - 1. The contractor shall provide the Glycol/Water Tank and Pump Assembly as detailed on the drawings.

2.4 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with new and existing piping system components and connected equipment, and that can attain water quality specified.

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 CLEANING AND FLUSHING

- A. The water treatment contractor shall fill, circulate and treat the Chilled Water and Heating Hot Water System piping with a cleaning solution consisting of recommend chemical agents and acids to thoroughly clean and prepare the piping systems for the introduction of the 30% glycol and de-ionized water solution. The contractor shall carefully work with the mechanical contractor to open valves and control valves to circulate cleaning solution through all piping systems, coils, valves and equipment.
- B. During the cleaning process, the water treatment contractor shall inspect the treated piping systems for leaks and notify the contractor and Ogden School District Maintenance Department of any deficiencies or leaks encountered.
- C. The water treatment contractor shall flush the Chilled Water and Heating Hot Water System piping clean of the cleaning solution and introduce a water and 30% by volume propylene glycol solution to each system. System volumes shall be carefully volume metered and monitored by the water treatment contractor.

3.3 INSTALLATION

- A. Install glycol feeder on 4 inch high concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor tanks and floor-mounting accessories to substrate.
- B. Make all required piping connections to the chilled and heating hot water systems.
- C. Install interconnecting control and alarm wiring for chemical treatment controls and sensors.
- D. Mount sensors and injectors in piping circuits.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results for HVAC."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.
- F. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
- G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 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 glycol solution 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 HVAC 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.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 2501

SECTION 23 2600 - CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Furnish and install condensate drain piping as described in Contract Documents.

1.2 REFERENCES

- A. American Society For Testing And Materials:
- B. ASTM B 88-03, 'Standard Specification for Seamless Copper Water Tube.
 - 1. ASTM B 88-03, 'Standard Specification for Seamless Copper Water Tube.'

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Condensate Drains:
 - 1. Type M copper meeting requirements of ASTM B 88 or Schedule 40 solid core PVC plastic pipe for condensate drains from boiler drain and neutralization tank kits.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Condensate Drains:
 - 1. Support piping and protect from damage.
 - 2. Slope piping 1 inch in every 40 feet of run toward approved floor drain, floor sink or other approved drainage point.
 - 3. Install condensate drain lines from each boiler neutralization tank. Extend drains to nearest floor sink, floor drain or vent line as indicated.

END OF SECTION 23 2600

SECTION 23 2923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes solid-state variable frequency drives (s) for speed control of three-phase, squirrel-cage induction fan motors.

1.2 SUBMITTALS

- A. Product Data: For each type of VFD.
- B. Shop Drawings: For each VFD.
 - 1. Include wiring diagrams.
 - 2. Location of in relation to equipment served
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.
- B. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
 - 2. Yaskawa Corp
 - 3. Toshiba International Corporation.

2.2 VARIABLE FREQUENCY CONTROLLERS

- A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
1. Provide unit suitable for operation of [standard] [premium]-efficiency motor as defined by NEMA MG 1.
- B. Design and Rating: Match load type for fans; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- D. Unit Operating Requirements:
1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
 2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
 3. Minimum Efficiency: 96 percent at 60 Hz, full load.
 4. Minimum Displacement Primary-Side Power Factor: 96 percent.
 5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 6. Starting Torque: 100 percent of rated torque or as indicated.
 7. Speed Regulation: Plus or minus 1 percent.
- E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
1. Electrical Signal: 4 to 20 mA at 24 V.
- F. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 2 to a minimum of 22 seconds.
 4. Deceleration: 2 to a minimum of 22 seconds.
 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- G. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
 2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 5. Instantaneous line-to-line and line-to-ground overcurrent trips.
 6. Loss-of-phase protection.
 7. Reverse-phase protection.
 8. Short-circuit protection.
 9. Motor overtemperature fault.
- H. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- I. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

- J. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- K. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- L. VFD Output Filtering: Drives shall be protected from natural frequency, line transients imposed by powerlines. Provide harmonic filters in accordance with IEE519
- M. Status Lights: Door-mounted LED or Digital Display indicators shall indicate the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches.
- O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).
 - 3. Motor status (running, stop, fault).
 - 4. Motor current (amperes).
 - 5. Motor torque (percent).
 - 6. Fault or alarming status (code).
 - 7. PID feedback signal (percent).
 - 8. DC-link voltage (VDC).
 - 9. Set-point frequency (Hz).
 - 10. Motor output voltage (V).
- P. Control Signal Interface:
 - 1. Pneumatic Input Signal Interface: 3 to 15 psig
 - 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
 - 3. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- Q. Communications: Provide an RS485 interface allowing VFD to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFD to be programmed via BMS control. Provide capability for VFD to retain these settings within the nonvolatile memory.
- R. Manual Bypass: None
- S. Bypass Controller: None
- T. Integral Disconnecting Means: NEMA KS 1, fusible switch with lockable handle.
- U. Isolating Switch: Non-load-break switch arranged to isolate VFD and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
- V. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 ENCLOSURES

- A. Manufacturers standard.

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Standard Displays:
 1. Output frequency (Hz).
 2. Set-point frequency (Hz).
 3. Motor current (amperes).
 4. DC-link voltage (VDC).
 5. Motor torque (percent).
 6. Motor speed (rpm).
 7. Motor output voltage (V).
- F. Historical Logging Information and Displays:
 1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.

- G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to VFDs before shipping.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.

3.2 INSTALLATION

- A. Install new fan motor VFDs on wall or adjacent to each existing multizone or single zone air handler. Locate variable frequency drives where indicated on the drawings or compatible with the existing fan motor systems.
- B. Comply with manufacturer's recommendations regarding mounting and anchoring requirements.
- C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26

3.3 IDENTIFICATION

- A. Identify VFDs, components, and control wiring according to Division 23 Section "Identification for HVAC Piping and Equipment."
- B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of or above VFD units.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices according to Division 26
- B. Bundle, train, and support wiring in enclosures.
- C. Connect automatic-control devices where applicable.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION 23 2923

SECTION 23 3113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rectangular ducts and fittings.
 - 2. Sheet metal materials.

1.2 GENERAL

- A. Provide new galvanized sheet metal supply air duct systems as indicated on the drawings.
- B. Make compatible connections and transition from existing fiberglass duct systems to new sheet metal duct systems where indicated.
- C. Coordinate installation of new sheet metal duct systems with existing structure, electrical, plumbing and mechanical systems.

PART 2 - PRODUCTS

2.1 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.

2.2 SHEET METAL MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.

2.3 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. Water-Based Joint and Seam Sealant:

2.4 HANGERS AND SUPPORTS

- A. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

- B. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans indicate general location and arrangement of duct system.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

3.2 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."

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

END OF SECTION 23 3113

SECTION 23 5100 - BOILER FLUES AND COMBUSTION AIR PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Listed high density polypropylene flues and combustion air piping
 - 2. Boiler flues and combustion air piping shall be per manufacturer's recommendations.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Factory fabricated polypropylene vent pipe for use with ANSI Category II and IV gas-burning appliances, including high efficiency condensing boilers suitable for exhaust temperatures up to 230°F and a maximum positive pressure of 15 in-w.c.
 - 2. Factory fabricated polypropylene combustion air pipe for use with high efficiency condensing boilers.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Rigid pipe constructed of 2.2mm thick polypropylene.
- B. Fittings: Tees, elbows, increasers, caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
 - 1. Stack cap designed to exclude minimum 90 percent of rainfall.
 - 2. Sealant: Manufacturer's standard high-temperature sealant.
- C. 0" clearance to combustibles for exhaust temperatures up to 194°F
- D. Sizes: 12"
- E. Provide boiler manufacturers required transitions.
- F. Manufacturer: Duravent PolyPro

PART 3 - EXECUTION

3.1 INSTALLATION OF FLUES AND COMBUSTION AIR PIPING

- A. Remove existing boiler flues complete. Maintain existing roof openings. Install new boiler flue and combustion air piping of size indicated. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing.

- B. Install polypropylene combustion air and boiler flue piping as indicated and in accordance with manufacturers written instructions. Make all required connections to boilers providing required transitions and offsets as needed to facilitate and coordinate installation with existing mechanical, electrical and piping trades.
- C. Seal between sections of piping and fittings according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- D. Support piping at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- E. Slope boiler flue piping down in direction of appliance, with rain water drain connection at lowest point piped to nearest drain.
- F. Furnish and install roof termination caps.
- G. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- H. Paint all boiler flue and combustion air piping exposed to sunlight with two coats of UV resistant paint. Color: White

END OF SECTION 23 5100

SECTION 23 5200 - HYDRONIC PUMPS AND SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. The installation covers the furnishing and installing of heating hot water pumps, piping systems, and all necessary trim and specialties, etc., as specified and shown on drawings or as required to provide the complete heating hot water systems shown on the drawings and specified herein.

PART 2 - PRODUCTS

2.1 BASE-MOUNTED PUMPS

- A. Furnish and install the close coupled, base mounted variable speed pumps of the size, type and capacity indicated on the drawings.
- B. All base mounted pumps shall be single stage, non-over loading, centrifugal volute type. Impellers shall be bronze and shall be dynamically balanced. Bearings shall be of the ball or roller type and the shaft of stainless steel.
- C. Pumps shall be provided with leakless mechanical shaft seal. All pumps shall be provided with flexible couplings which shall impose no restriction or normal end play or expansion.
- D. Each pump shall be provided with a cast iron or steel base plate of ample size to hold both the pump and motor in alignment. Pumps and motor shall be aligned when running at normal temperature. Final alignment shall be made immediately prior to testing under the supervision of a representative of the pump manufacturer.
- E. All pumps shall operate at 1750 RPM. Motors shall be phase and voltage specified on plans, horizontal ball bearing, drip proof. Pumps shall be designed in accordance with the standards of the Hydraulic Institute, including the latest modifications.
- F. Non-Overloading: Motor brake horsepower shall not be exceeded at any point of the pump characteristic curve.
- G. Rising Curve: Pump characteristic curve shall rise continuously from maximum capacity to shut-off, with shut-off head minimum 10 percent greater than the design head, except for double suction pumps to shut-off head shall be 20 percent greater than design head.
- H. Working Pressure: Construct pumps for the working pressure in pounds per square inch specified or indicated. Factory test at 1.5 times working pressure.
- I. High points of pump casing shall be provided with air vent cocks.
- J. Premium efficiency motors shall be based on CEE premium efficiency criteria for OPD motors at 1800 RPM.
- K. Pumps shall be as manufactured by Bell & Gossett or Taco.

2.2 INLINE PUMPS

- A. Furnish and install the inline wall mounted pumps of the size, type and capacity indicated on the drawings.

- B. All inline wall mounted pumps shall be single stage, non-over loading, centrifugal volute type. Impellers shall be bronze and shall be dynamically balanced. Bearings shall be of the ball or roller type and the shaft of stainless steel.
- C. Pumps shall be provided with leakless mechanical shaft seal.
- D. Pumps and motor shall be aligned when running at normal temperature.
- E. All pumps shall operate at 1750 RPM. Motors shall be phase and voltage specified on plans,. Pumps shall be designed in accordance with the standards of the Hydraulic Institute, including the latest modifications.
- F. Non-Overloading: Motor brake horsepower shall not be exceeded at any point of the pump characteristic curve.
- G. Rising Curve: Pump characteristic curve shall rise continuously from maximum capacity to shut-off, with shut-off head minimum 10 percent greater than the design ..
- H. Working Pressure: Construct pumps for the working pressure in pounds per square inch specified or indicated. Factory test at 1.5 times working pressure.
- I. Premium efficiency motors shall be based on CEE premium efficiency criteria for OPD motors at 1800 RPM.
- J. Pumps shall be as manufactured by Bell & Gossett or Taco. Pumps supplied with boilers shall be as manufactured by Grundfos.
- K. Provide wall mounting support brackets for securing inline pumps to wall.

2.3 PUMP SUCTION DIFFUSERS

- A. Pump suction diffusers to match the system pipe size and pump inlet size shall be furnished and installed where shown on the drawings. Units shall consist of angle type body with inlet vanes and combination diffuser-strainer-orifice cylinder. Suction diffuser shall be Bell & Gossett, or Taco.

2.4 AIR SEPARATORS

- A. Type: Provide air separators of tangential type constructed of steel and tested and stamped in accordance with section 8 of the ASME Code for a working pressure of 125 psig.
- B. Provide separators on hydronic systems capable of separating not less than 80 percent of the entrained air on the first passage of water and not less than 30 percent of residual air on each subsequent passage through the separator.
- C. Provide flanged inlet and outlet connections, 3/4-inch diameter valve drain connection and 1-inch diameter top air eliminator connection.
- D. Provide 1-inch diameter pipe from the top air eliminator point to a 5 gallon, steel, ASME stamped 125 pound working pressure air receiver vessel with automatic float vent.
- E. Provide 1-inch diameter globe valve between the air separator and the air receiver.
- F. Air Separators shall be as manufactured by Bell & Gossett or Taco.

2.5 EXPANSION TANKS

- A. Furnish and install pre-pressurized diaphragm-type expansion tanks of sizes indicated on the drawings.

- B. Construct tanks of steel in accordance with section 8 of the ASME Code for a working pressure of 125 psig. Test and stamp tanks for the working pressure.
- C. Support tanks on 2-inch diameter steel pipe legs with cross bracing and floor plates or suspend on steel saddles with all-thread rod anchored to the structure.
- D. Expansion Tanks shall be as manufactured by Bell & Gossett or Taco.

PART 3 - EXECUTION

3.1 COORDINATION

- A. All equipment and piping shall be arranged to allow for easy maintenance and access to service valves.
- B. Provide valves and unions or flanges at all pieces of equipment to allow maintenance.
- C. Install all automatic valves, sensor well, flow switches, etc., as directed by the control contractor.

3.2 INSTALLATION OF PUMPS

- A. General: Install pumps where indicated and in accordance with manufacturer's published installation instructions.
- B. Support: Install floor mounted pumps on minimum of 4-inch high concrete base. Provide anchor bolt inserts poured in place. Pumps shall be mounted with cap screws.
- C. Install inline pumps on wall supported with galvanized unistrut and pipe clamps.
- D. Grout base mounted pumps level. Align pump shafts.

3.3 INSTALLATION OF EXPANSION TANKS

- A. General: Install expansion tanks where indicated and in accordance with manufacturer's published installation instructions.
- B. Support: Install floor mounted tanks on minimum of 4-inch high concrete base. Provide anchor bolt inserts poured in place. Seismic brace tank to structure using cable braces or brackets.

3.4 INSTALLATION OF AIR SEPERATORS

- A. General: Install air separators where indicated and in accordance with manufacturer's published installation instructions.
- B. Support: Support air separators from overhead structure. Seismic brace seperator to structure using cable braces or brackets.

END OF SECTION 23 5200

SECTION 23 5216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged, factory-fabricated and assembled, gas-fired, fire-tube condensing boilers, trim and accessories for generating hot water.

1.3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
- B. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 50% and 7% input firing rates at incoming water temperatures ranging from 80°F to 160°.
- C. Pressure Drop Curve. Submit pressure drop curve.
- D. Shop Drawings: For boilers, boiler trim and accessories include:
- E. Source Quality Control Test Reports: Reports shall be included in submittals.
- F. Field Quality Control Test Reports: Reports shall be included in submittals.
- G. Operation and Maintenance Data: Data to be included in boiler emergency, operation and maintenance manuals.
- H. Warranty: Standard warranty specified in this Section

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: The manufacturer must have been regularly engaged in the manufacture of condensing hydronic boilers for not less than thirty (30) years.
- B. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. AHRI Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and is capable of achieving the energy efficiency and performance ratings within prescribed tolerances.
- D. ASME Compliance: Condensing boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
- E. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

- F. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- G. UL Compliance: Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.5 WARRANTY

- A. Standard Warranty: Boilers shall include manufacturer's standard form in which 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. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
 - 2. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from shipment.
 - 3. All other components, with the exception of the igniter, flame detector and O₂ sensor, are conditionally guaranteed against any failure for (18) eighteen months from shipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. This specification is based on the Benchmark Standard Series boilers as manufactured by AERCO International Inc. Equivalent units and manufacturers must meet all performance criteria, and will be considered upon prior approval.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide AERCO International, Benchmark Boilers:
 - 1. BMK 5000 BTU/hr input
 - 2. Approved Equals:
 - a. Viessmann Vitocrossal
 - b. Buderrus

2.2 CONSTRUCTION

- A. Description: Boiler shall be natural gas fired, fully condensing, fire tube design. Power burner shall have full modulation, discharge into a positive or negative pressure vent and the minimum firing rate shall not exceed the capacity noted on the drawings.

Boiler shall be factory-fabricated, factory-assembled and factory-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.
- B. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tube sheets, with a one-pass combustion gas flow design. The fire tubes shall be 1/2" or 5/8" OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tube sheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tube sheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8-inch diameter.

The boiler water pressure drop shall not exceed 6.5 psig @ 600 gpm

- E. Modulating Air/Fuel Valve and Burner: The boiler burner shall have a turn down ratio of 12:1 or better. The burner shall not operate above 7.5% oxygen level or 55% excess air. The burner shall produce less than 20 ppm of NO_x, under standard calibration, corrected to 3% excess oxygen when firing on natural gas. The burner shall be metal-fiber mesh covering a stainless steel body with spark or proven pilot ignition and flame rectification.
- F. Fuel: The boiler shall use one of the following gas train options:
 - 1. Natural gas: The unit gas train shall be specifically designed and calibrated for a single predetermined fuel. The gas train shall be a ventless gas train.
- G. Minimum boiler efficiencies shall be as noted on the drawings.
- H. Exhaust Manifold: The exhaust manifold shall be of corrosion resistant cast aluminum or 316 stainless steel.
- I. Blower: The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.
- J. Ignition: Ignition shall be via spark or proven pilot ignition with 100 percent main-valve shutoff and electronic flame supervision.
- K. Combustion Air: The boiler shall be designed such that the combustion air is drawn from the inside of the boiler enclosure, decoupling it from the combustion air supply and preheating the air to increase efficiency.
- L. Combustion Air Filter: The boiler shall be equipped with an automotive high flow air filter to ensure efficient combustion and unhindered burner components operation.
- M. Enclosure: The plastic and sheet metal enclosure shall be fully removable, allowing for easy access during servicing.
- N. O₂ sensor located in the Combustion Chamber: The boiler shall be equipped with an Oxygen sensor. The sensor shall be located in the boiler combustion chamber. Boilers without Oxygen sensor or boilers with an Oxygen sensor in the exhaust shall not be acceptable due to measurement estimation and performance accuracy.

2.3 CONTROLS

- A. Refer to Division 23, Section "Instrumentation and Control of HVAC."
- B. The boiler shall have an integrated boiler control that provides contact closure for its associated accessories including but not limited to pump, valve and air inlet damper.
 - 1. The control shall have a color touch screen display as well as six function buttons that are separate from the display. User shall have the ability to navigate the menus via touch screen or navigation buttons. Controls not equipped with navigation button options shall not be permitted. The control shall be equipped with a multi-color linear LED light to indicate the level of firing and/or air/fuel valve position.

The control shall display two temperatures using two dedicated three-digit seven-segment displays. The control shall offer an Enable/Disable toggle switch as well as two buttons for Testing and Resetting the Low Water Cutoff.

- C. The control system shall be segregated into three components: Edge [i] Control Panel, Power Panel and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized
- D. The control panel shall consist of seven individual circuit boards using surface-mount technology in a single enclosure. Each board shall be individually field replaceable. These circuit boards shall include: A microcontroller board with integrated 5 inch touchscreen color display providing the user interface.
- E. Combustion calibration: The control shall offer at least 5 calibration points.
- F. Software update: The control shall be capable of field software updates without a need for hardware component(s) replacement.
- G. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities.
- H. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1.
- I. Each boiler shall utilize a low cost reliable automotive O₂ sensor that measures and monitors the oxygen content of the exhaust gases.
- J. Each boiler shall have integrated Boiler Sequencing Technology (BST), capable of multi-unit sequencing with lead-lag functionality and parallel operation. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant.
- K. When set on Indoor/Outdoor Reset Mode, the ACS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.

When set on MODBUS Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint as an external communication utilizing the MODBUS protocol is supplied via the RS-232 port.

2.4 ELECTRICAL POWER

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.

2.5 VENTING

- A. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with operating temperatures up to 230°F, condensing flue gas service. UL-listed vents of Polypropylene must be used with boilers.
- B. The minimum exhaust vent duct size for each boiler is 12 inch
- C. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a Polypropylene duct connected between the boiler and the outdoors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation 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 boiler performance, maintenance and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations 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. Install boilers level on new concrete bases.
- 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 Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to boiler to permit service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return boiler tapplings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting
 - 1. Install flue venting and combustion-air intake piping.
 - 2. Connect venting full size to boiler connections.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Perform hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. 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. Remove and replace malfunctioning units and retest as specified above.
- E. Performance Tests:

The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following performance tests:

END OF SECTION 23 5216

SECTION 23 5700 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes plate and frame heat exchangers. Water / 30% Glycol-Water

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

PART 2 - PRODUCTS

2.1 PLATE AND FRAME HEAT EXCHANGERS

- A. Manufacturers:
 - 1. ITT Industries; Bell & Gossett.
 - 2. Taco, Inc.
- B. Configuration: Plate and Frame. See Drawings
- C. Materials: AISI 304 Plates
- D. Gasket: NBR HT
- E. Frame: SA 516 Gr.70 Pressure Plates
- F. Piping Connections:
 - 1. Inlet and outlet fluid connections, threaded drain, and vent connections.
- G. Capacity and Characteristics: As Indicated on the Drawings

PART 3 - EXECUTION

3.1 HEAT-EXCHANGER INSTALLATION

- A. Install plate and frame heat exchangers on 4 inch high concrete pad.

3.2 CONNECTIONS

- A. Install shutoff valves at heat-exchanger inlet and outlet connections.
- B. Install ATC control valves where indicated or direct by ATC contractor.
- C. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.
- D. Install thermometers on inlet and outlet of heating hot water connections.

END OF SECTION 23 5700

SECTION 23 6426 – AIR COOLED CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: The installation covers the furnishing and installing of air cooled chiller and all necessary trim and specialties, etc., as specified and shown on drawings or as required to provide the complete air conditioning systems shown on the drawings and specified herein.

PART 2 - PRODUCTS

2.1 CHILLED WATER SPECIALTIES

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of water piping. Install piping as indicated unless deviations to layout are approved. Furnish and install complete the chilled water specialties including the air separation tanks, bladder type expansion tanks, tank fittings, air vents, and specialty items required to make a complete and operable chilled water system as shown on the drawings and as required to complete system intended.

2.2 AIR COOLED CHILLER

- A. General: Provide air cooled, multiple scroll compressor chiller where indicated, of size, quantity, rating, capacity, and characteristics scheduled, each consisting of multiple scroll compressors with independent circuiting, compressor motors, evaporators, condenser, controls, starters and panels including gauges and indicating lights, auxiliary components and accessories required for complete chiller installation.
- B. Chiller shall be furnished with BACNET interface for connection with school districts DDC controls.
- C. Maximum acceptable EER = 9.48 with 30% propylene glycol/water solution, 100 deg F ambient temperature and 4300 ft altitude.
- D. Provide manufacturer's standard chiller specified in published product information, designed and constructed in conformance with this Section.
- E. Provide lifting eyes or other means of lifting on all removable components weighing 50 pounds or more.
- F. Motor Starters: Provide a motor starter for each compressor, UL listed, of the magnetic star-delta either open or closed transition type. Provide magnetic, manual reset overload relays in each phase and undervoltage release.
- G. Provide dual point power connection as indicated.
- H. Provide ammeter, and voltmeter to read each phase and an hourly run-time meter mounted in the starter cover.
- I. Condensers shall consist of heavy duty copper tube/solid or flat plate aluminum finned coil sections with multiple direct drive condenser fans staged to provide condensing of the refrigerant. Split, lanced fin or enhanced aluminum finned condenser sections are not allowed.

- J. Evaporators: Provide evaporators of the shell-and-tube direct expansion type, designed, fabricated, tested, inspected and certified to comply with ASHRAE 15 and in accordance with ASME Boiler and Pressure Vessel Code, Section VIII. Limit tube velocities to those recommended by manufacturer.
- K. Provide pressure relief devices, manufacturer's standard complying with ASHRAE 15. Provide relief valves for high pressure refrigerant chillers. Sign evaporator for circulation of scheduled fluid flow rates and pressure drops. Equip evaporator with refrigerant charging and transfer connections.
- L. Provide tube sheets of steel, self-supporting, and sufficient strength to withstand working pressures, and weld to vessel shells. Provide intermediate tube sheets, maximum 5 feet on center, to prevent tube vibration.
- M. Provide heat-transfer tubes, minimum 0.028 inches wall thickness, measured at the thinnest point of the tube wall after finning or other tube enhancements, and arrange to be individually removable. Expand ends of tubes in tube sheets and ensure tubes fit tightly enough in the supports so that tubes shall not be subject to either crevice-corrosion failure or chafing-due-to-vibration failure.
- N. Provide, manufacturer's fabricated steel water boxes with flanged water connections, designed, fabricated, tested, inspected, certified and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII. Bolt to shell of the vessel. Provide removable covers and arrange external piping and fittings for clear access to the entire tube sheet.
- O. Insulation: Provide factory installed weatherproof and UV resistant insulation on the evaporator of the polyvinylchloride nitrile, neoprene or mixtures of these as a closed-cell type foam having a minimum density of four pounds per square foot with a maximum thermal conductivity of 0.28 Btu per hour per inch thickness per degree F. per square foot at 75 degrees F. Minimum thickness shall be 3/4-inch. The insulation shall be cemented in place with a rubber based adhesive; all joints shall be neatly taped, or otherwise sealed, to provide vapor sealed joints Base capacity ratings on factory applied insulation at 60 to 100 degrees F. ambient temperature.
- P. Safety Controls: Provide factory wired safety controls to stop compressor if any of the following occurs. Design each cut-out to require manual resetting before compressor will start.
 - 1. Low refrigerant pressure in evaporator.
 - 2. High condenser pressure.
 - 3. High motor-winding temperature.
 - 4. Low differential oil pressure.
 - 5. Loss of any phase in electric power.
 - 6. High oil temperature.
 - 7. High bearing-temperature.

Operational Controls: Provide a control system as follows:

- 1. Provide controls to ensure that compressors will start under unloaded condition.
- 2. Provide an anti-recycle timer, factory-wired, to limit compressor-motor restarts at scheduled intervals.
- 3. Provide a low evaporator-water-leaving-temperature cut-out with manual reset.
- 4. Control oil pump (as applicable) to ensure lubrication of compressor motor bearings and seals.
- 5. Start main oil pump (as applicable) before compressor starts.
- 6. Prove oil pressure (as applicable) through pressure interlock.
- 7. Maintain lubrication during normal operation.
- 8. Automatically restart compressor after power-failure provided anti-recycle timer is ready for restart.

Control Panel: Manufacturer's design complying with the National Fire Protection Association (NFPA) 70, "National Electrical Code."

1. Provide gauges or meters or LED read out to indicate refrigerant pressure and temperature in evaporator and condenser, and oil temperature and pressure.
2. Provide electrical interlock to prevent chiller operation when condenser-water pump is not operating.
3. Provide electrical interlock to prevent chiller operation when chilled-water pump is not operating.

Running and Warning Indicators: Provide warning lights with nameplates or a safety alarm light working in conjunction with self diagnostic, digital circuitry which displays status in an LCD for the following:

1. Oil pump operation, "Normal." (As applicable)
 2. Low chilled water temperature cutout.
 3. Low water flow cutout.
 4. Oil heater operation, "Normal."
 5. Low evaporator refrigerant pressure or temperature cutout.
 6. High condenser pressure cutout.
 7. High motor-winding temperature cutout.
 8. Low oil pressure cutout.
 9. Motor-overload cutout.
 10. Provide elapsed time meter designed to automatically record total chiller operating time, in hours.
- Q. Sound Attenuation: Provide manufactures standard sound attenuation package consisting of insulation, baffles and other devices to limit sound pressure rating to 50 dBa at the school's property line.
- R. Factory Finish: Provide manufacturer's standard finish
- S. Compressors shall carry a manufacturer's full 5-year warranty for parts and labor.
- T. Manufacturer: Air Cooled Chiller shall be Carrier Model 30RB170 (Quality Standard).
- U. Subject to the above requirements other approved manufacturers include Trane, Daikin-McQuay, Dunham-Bush or York

PART 3 - EXECUTION

3.1 CHILLER INSTALLATION

- A. Drawing plans, schematics indicate location and arrangement of chiller installation.
- B. Install chiller in accordance with manufacturer's installation instructions. Install unit plumb and level in locations indicated, and maintain manufacturer's recommended clearances.
- C. Install units on 6 inch high reinforced concrete pad, 48 inches larger on each side than chiller base. Cast anchor bolt inserts into the pad.
- D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26.
- E. Relief Piping: Provide relief piping as indicated from refrigerant pressure relief valve on chiller to atmosphere. Provide size as recommended by chiller manufacturer, and terminate with gooseneck facing down.
- F. Control: Coordinate field-installed automatic temperature control requirements with other sections of Division 23 and Division 25 Controls.

- G. Manufacturer's Supervision: Chiller manufacturer shall supervise field assembly (if any) and installation of chiller work, with factory-trained technical service representative, for minimum of 2 working days, plus one additional day for each chiller unit in excess of one. Prepare manufacturer's written report of installation, signed by representative.
- H. Testing and Lubrication: Include leak testing, evacuation, dehydration, vacuum pumping, and charging in scope of supervision by manufacturer's representative. Include lubrication, including filling of reservoirs, and confirming that lubricant is of quantity and type recommended by manufacturer in scope of supervision by manufacturer's representative.
- I. Paint damaged and abraded factory finish with touch-up paint matching factory finish.
- J. Grounding: Provide positive electrical equipment ground for chiller equipment and components where indicated.
- K. Start-Up: Start-up air cooled scroll chillers, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment. Furnish sufficient refrigerant and dry nitrogen for pressure testing under manufacturer's supervision.

END OF SECTION 23 6426

SECTION 23 7313 – AIR HANDLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Refurbishment of the existing multi-zone and single zone air handlers indicated on the drawings.
- B. Work to include the removal of existing steam coils, associated steam and condensate piping, installation of new heating hot water coils, repurposing of existing chilled water coils, installation of new chilled water piping, installation of new fan motors complete with matching VFD, installation of new air dampers and damper actuators, installation of new DDC controls, installation of new air filters and complete commissioning of the existing air handlers to provide heating and cooling indicated and as required to provide the complete heating and air conditioning systems shown on the drawings and specified herein.

PART 2 - PRODUCTS

2.1 METHODS

- A. A complete and ample system of chilled and heating hot water piping shall be installed as shown on the plans, properly graded and supported to prevent water and air pockets from forming, and to insure noiseless circulation throughout the system.
- B. Furnish and install complete the chilled and hot water specialties including the air separation tanks, bladder type expansion tanks, tank fittings, air vents, and specialty items required to make a complete and operable chilled water and heating hot water system as shown on the drawings and as required to complete system intended.
- C. Manual air vents shall be installed at all high points in the water system. Air vents shall be 3/8" ball valves and shall be installed on a 1/2" pipe nipple 6" long. Run 1/4" copper tube from vent to near floor or floor drain anchor tube securely to wall, pipe, or structural member.
- D. Drains shall be installed at all low points. Drain valves shall be 1" ball or motorized solenoid valves as indicated. Pipe all drain lines to nearest floor sink, floor drain or receptacle.
- E. Pipe supports, anchors, and other accessories shall be provided as shown and detailed on the plans or as called for in the specifications.
- F. Chilled and heating hot water piping shall extend to new heating hot water coils and existing chilled water coils at each air handler as indicated. Make all required piping connections to the coils. Make all required installation of hydronic specialties including air vents, controls, valves and unions at each coil connection.
- G. Interface and coordinate with the temperature controls contractor for installation of all heating hot water and chilled water three-way control valves at each coil connection.
- H. All mains reducing in size shall be reduced with eccentric reducing fittings. Run all piping as high as possible in mechanical rooms. Coordinate location of all new chilled water piping and heating hot water piping with existing piping and air handlers. Provide offsets as needed to avoid building structure, lighting, existing piping, conduit, fire sprinkler piping and other obstructions.

- I. Remove existing steam coils at each multizone or single zone air handler complete. Remove all associated steam and condensate piping complete.
- J. Install new heating hot water coils as part of the existing multizone or single zone air handler. Fabricate sheet metal sections as needed to facilitate installation and accommodation of the new heating hot water coils.
- K. Remove existing fan motors from each multizone air handler or single zone air handler and replace with new fan motor complete with matching variable frequency drive.
- L. Remove existing pneumatic controls complete including all pneumatic dampers and damper actuators. Install new low leak dampers for return and outside air at each air handler provide new DDC control actuators for each damper.
- M. Remove and install new MERV 8 filters at each air handler as part of the new work.
- N. Install new multizone DDC dampers for each air zone. Dampers shall be connected to existing control linkages for hot deck and cold deck control. Damper actuators shall be furnished by the controls contractor and installed by the mechanical contractor.
- O. Commission each air handler to provide the CFM indicated.

2.2 WATER COILS:

- A. Coils shall be multiple row type, constructed of 5/8" diameter .035 inches thick type copper tubes with .010 thick expanded aluminum fins on the tubes.
- B. Casing material shall be minimum 14 gauge galvanized steel. Headers shall be heavy wall copper or stainless steel. Provide ¼ air vents.
- C. Connections shall be bottom supply – top return, flanged or roll grooved to match piping system. Coils shall be multiple row and sectionalized to facilitate installation into the existing air handler coil sections.
- D. Contractor shall work closely with their equipment supplier to provide custom coil sections compatible with the existing air handler coil sections.
- E. Coils shall be Carrier, Trane, York, USA Coil, RAE Corp, Temptrol or prior approved alternates.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of water piping and work required. Install piping as indicated unless deviations to layout are approved.
- B. Make all required air handler improvements and connections to provide for a complete and functional heating hot water and chilled water cooling system.
- C. Integrate new DDC controls into the existing multi zone air handlers and single zone air handlers. Provide new DDC control actuators for each air handler and control of the hot deck cold deck systems. Provide

new three-way heating hot water and chilled water control valves for control of the heating and cooling coils as part of the air handler refurbishment.

- D. Field test all actuators motors and components to verify correct operation.
- E. All equipment and piping shall be arranged to allow for easy maintenance and access to service valves.
- F. Provide valves and unions or flanges at all pieces of equipment to allow maintenance.
- G. Install all automatic valves, sensor well, flow switches, etc., as directed by the control contractor.
- H. Furnish and install heating hot water coils in existing air handlers as scheduled and noted on the drawings. Coordinate installation of water coils with existing conditions. Remove, modify and improve existing air handler coil sections as needed to install the water coils. Remove and disconnect existing conduit, wiring, heating hot water piping and other appurtenances as needed to install the coils. Where required, provide multiple coil sections as needed to facilitate installation. Provide branch coil connections manifold as needed to meet overall capacity of water coils. Make all required chilled and heating hot water connections.
- I. Provide miscellaneous galvanized steel blank-off plates and framing to install coils. Place coils over existing air handler drain pan and ensure coils drain as required.
- J. Install manual air vents at each water coil.
- K. Install chilled water coil specialties including coil connections, flanges, isolation valves, balancing valves and strainers as indicated on the drawings and noted in these specifications.
- L. Furnish and install the 3-way water coil control valves as indicated. Contractor shall furnish and install the coil control valves and actuators as specified in section 25 1000. Low voltage control wiring and conduit to the valve actuators shall be provided and installed by the Controls Contractor. The controls contractor shall coordinate purchasing, installation and connection of the valves with the mechanical contractor to provide a complete and functional chilled and heating hot water coil control system.
- M. Remake or re-install any and all connections of electrical conduit, wiring, panels, heating hot water piping etc which was disconnected in order to install the chilled coils. Return systems to their original condition.

END OF SECTION 23 7313

SECTION 25 1000 - AUTOMATIC TEMPERATURE CONTROLS

1.0 GENERAL

1.1 GENERAL CONDITIONS

- A. The General Conditions, Supplementary General Conditions, alternates and addenda, applicable drawings and the technical specifications, shall all apply to all work under this division.

1.2 SUMMARY

- A. This Section includes control equipment for new air-cooled chiller, boilers, pumps, heat exchangers and equipment not supplied with factory-wired controls.
- B. This Section includes the removal of all existing pneumatic control systems within the building including all controls serving existing multizone air handlers and single zone air handlers.
- C. This Section include the removal of all existing pneumatic steam valves controls on all air handler steam coils, hydronic controls for existing convectors, coils and existing cabinet unit heaters.
- D. This Section includes the removal of all existing pneumatic return and outside air dampers and their associated controls serving the existing multi-zone air handling units, the single zone air handling units, the make up air units, existing exhaust fan dampers and all other dampers indicated on the drawings. New dampers and new damper actuators are to be provided for all, relief, return and outside air ducts serving the existing multi-zone air handling units, the single zone air handling units and exhaust fans.
- E. The existing multi-zone branch dampers are to remain in place and be fitted with new DDC actuators and DDC controls for each zone.
- F. Existing chilled water coils at the existing air handlers are to be fitted with new 3-way coil control valves as part of the new chilled water cooling system for the building.
- G. Existing steam coils are to be removed complete and replaced with new heating hot water coils complete with new 3-way coil control valves as part of the new heating hot water system for the building.
- H. All existing pneumatic or pneumatic/electric sensors and thermostats in classrooms, offices and ancillary spaces are to be removed and replaced complete with new DDC thermostats, sensors and controls for a complete and functional temperature control system.
- I. This Section includes the installation of all new hydronic control valves for the new heating hot water and chilled water systems linked to the new DDC control system.
- J. See "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3 SCOPE OF WORK

- A. The scope of work shall include all labor, material, and equipment necessary to extend the school districts DDC automatic temperature control system to the items noted in this specification.
- B. It is the intent of this contract to remove all existing pneumatic controls within the building and replace and integrate new DDC controls as provided and furnished by Control Systems International and Utah-Yamas as part of the new work. The existing temperature controls air compressor shall be removed and salvaged to the Ogden School District. The existing air dryer shall be removed and scrapped.

- C. It is the intent of this contract that existing pneumatic control actuators serving existing convectors, coils, cabinet unit heaters, unit heaters, multi-zone branches, single zone branches and all pneumatic sensors and thermostats be removed and replaced with new DDC control valves, sensors, thermostats and actuators for a complete and functional temperature control system.
- D. It is the intent of this contract that all new air-cooled chiller and boiler controls, pump controls and other DDC control devices, actuators and other items interface with the new mechanical equipment; so as to provide a complete and functional DDC control system upon completion of the work. Air-cooled chiller and boiler controls, pump controls shall be integrated into the system for complete monitoring and control.
- E. It is the intent of this contract that the new boiler and air cooled chiller system as part of the new DDC control system be fully BACnet compatible, communicable and integral with the existing Ogden School District DDC Control System located at the School District Maintenance Building.
- F. Provide Direct Digital Control (DDC) system for control of the systems indicated. This DDC control system shall be configured to operate over the existing district wide network in conjunction with existing DDC manufacture control systems. Multiple PC's shall be able to access the system simultaneously and permit full operation and adjustments without interruption.
- G. Provide the following:
- o Building Heating Hot Water System Control
 - o Boiler Control Panel Interface
 - o Heating Hot Water System Temperature and Pressure Sensors
 - o Heating Hot Water System Pressure Differential Sensors
 - o Domestic Hot Water System Pump Control
 - o Domestic Hot Water System Temperature Sensors
 - o Connectivity and Interface with all Pump VFD's
 - o Connectivity and Interface with all Pumps
 - o Outside Air Temperature Reference
 - o Building Chilled Water System Control
 - o Air Cooled Chiller System Control
 - o Boiler Motorized Isolation Valves
 - o Heating Water System Pressure Differential Sensor
 - o Glycol Feed wiring
 - o CO Sensors/Detectors
 - o Exhaust Fan Control
 - o 120 and 140 degree Domestic Hot Water Systems Control
 - o Connectivity and Interface with all VFD's
 - o Chilled water demand load limiting
- H. Demolition: Removal of all existing pneumatic controllers, valves, panels and wiring.
- 1.4 SUBMITTALS:
- A. Product Data: For each control device indicated.
- 1.5 SYSTEM DESCRIPTION:
- A. A system of DDC automatic temperature controls shall be provided as a part of this contract to give the owner complete control of the Chilled Water, Heating Hot Water and Domestic Hot Water Control Systems within the confines of the building. Manufacturer and installer shall be:
- Structureware, as supplied and installed by Utah/Yamas Controls.

- B. All heating hot water, chilled water control valves shall be normally open. No exceptions.
- C. Chilled water systems are to be freeze-protected by a glycol solution.
- D. Heating Hot Water systems are to be freeze-protected by a glycol solution only where indicated.
- E. DDC system shall be configured and connected to the district Ethernet/Network. System shall be accessible from any remote site through an Ethernet or internet connection. All functions, programs and control system parameters shall be accessible and fully functional through the district network. The ATC contractor shall supply and install all required hardware and software to permit full access to the DDC system for control of the Chilled Water, Heating Hot Water and Domestic Hot Water Control Systems.
- F. The ATC contractor shall verify that all new and existing DDC control points inside the school shall tie into OSD Lan Network. The ATC contractor shall include all software and hardware to permit district wide network and complete intranet access to the DDC system. This includes graphic pages, monitoring, alarming, trending, programming, database modifications, setpoint changes, DDC programming. All aspects and elements of the DDC control system shall be available across the entire district network.
- G. The system shall be as indicated on the drawings and specified herein. Building HVAC systems and unitary heating devices shall be entirely controlled by the DDC system. System shall include local DDC controllers mounted at each fan system, boiler, chiller, pump, etc. These local DDC controllers shall be interconnected by a 2-wire or 3-wire LAN (local area network) with a master/central DDC controller located in the Main Mechanical Room or Boiler Room as directed by owner.. The master/central DDC controller, in turn, shall communicate with both the existing school district host computer located in the district offices and a man-machine interface device located in the Main Custodian office. The owner provided device shall display on separate, bit-mapped color screens each fan system, convector, hot water coils, cabinet unit heater, fan-coil unit, central heating system and central cooling system. Each screen shall have available for display in the appropriate location each input and output point monitored or generated by the DDC system. All digital output points shall have override capability. All screens shall be password protected so that sensitive data cannot be easily corrupted by inexperienced operators while allowing complete access to trained maintenance personnel. All of the above screens, data and features shall also be available for monitoring and modification from the Host computer located in the District offices via Networking (Ethernet) connections.
- H. The latest technology DDC/Energy Management systems will be furnished and installed. As a standard, these systems will include graphics and data files for each building at the Ogden School District (OSD) maintenance office.
- I. The DDC/Energy system will be capable of different access levels for the different control and engineering functions of the system. The OSD maintenance staff will have access at the highest level to allow for DDC program, graphic pages, and other changes and additions.
- J. The DDC/Energy Management system will have dynamic alarm display capability. If an alarm should occur at a remote location or system, that alarm shall generate a message on whatever screen happens to be on the current display. All alarms shall be logged on the system printer. The system will be capable of printing logs and trends. It will also be capable of displaying graphic trend information for all points. Reference the alarm requirement section for more details on the energy alarms and system alarms.
- K. The DDC/Energy Management system will have a graphic and/or text page for each major mechanical piece of equipment or system (I.E.: boilers, chillers, fans, etc.). From these pages, there will be "live" readouts of temperatures, pressures, RH levels, on/off status, valve and damper positions, outside air temperature, etc. It shall be possible from this screen to perform setpoint changes, equipment on/off overrides, implement "test" status and values, without additional screen or program manipulation. Functions such as equipment schedules and reset schedules shall be accessed from editing screens. All functions shall be protected with different

levels and passwords.

- L. There will also be a floor plan(s) which will show the location of rooms, room sensors, etc., and will give a "live" display of the current condition of that location. Room temperatures will be adjustable from this graphic. Outside air temperature will also display on this graphic. Larger buildings will require more than one of these floor plan pages. No more than 40 points should be on any one page.
- M. All system and unitary controls shall be of the direct digital type (DDC). Self-tuning PID (Proportional, Integral, Derivative) control algorithms shall be applied where applicable on all applications. The control system shall be a networked, distributed intelligence system, with the control loops for each system being capable of stand-alone operation.
- N. The system shall include all control devices, valves and damper parts as called for hereinafter

1.5 WORK TO BE PERFORMED BY OTHERS

- A. Division 26 shall furnish and install all single phase and multiple phase electrical power wiring to magnetic starters, disconnect switches, VFD's and motors. Division 26 shall also provide 120 VAC, 20 Ampere power sources to each group of ATC panels. The ATC contractor shall be responsible for all step down transformers and 24 VAC wiring to ATC equipment.
- B. All ATC wiring shall be run in EMT conduit furnished and installed by the ATC contractor.
- C. Division 26 shall furnish all Boiler Shutdown Switches and CO (Carbon Monoxide) Sensor Monitoring and Alarm. ATC Contractor shall interface with those Switches, Sensors and Monitoring to provide alarm status for the system.
- D. The mechanical contractor shall install all valves, dampers and actuators supplied by the ATC contractor. Each damper shall be installed so that it will operate freely and without binding. To insure that the damper both opens and closes completely with less than 7#/sq. ft. torque applied at the operating shaft, each damper shall be checked after its installation, but before the damper actuators are attached. Dampers not properly installed or meeting this torque requirement shall be replaced and/or reinstalled without additional cost to the ATC contractor or the Ogden School District.
- E. The mechanical contractor shall install all motorized control and isolation valves, immersion wells and pressure taps supplied him by the ATC contractor.

1.6 INSTALLATION BY AUTOMATIC TEMPERATURE CONTROL (ATC) CONTRACTOR

- A. The ATC contractor shall furnish and install all necessary electrical control wiring and conduit for the complete temperature control system, cooling, heating and ventilating equipment motor starting circuit controls and all electrical control interlocks for same, and for control wiring for miscellaneous HVAC equipment furnished by the Owner.
- B. The ATC contractor shall furnish & install all necessary electrical control wiring and conduit of all temperature controls, cooling, heating and ventilating equipment motor starting circuit controls, all electrical control interlocks for same and for miscellaneous packaged equipment.
- C. All line and low voltage electrical and control wiring shall be installed in EMT conduit & in accordance with the National Electrical Code and applicable local codes and in accordance with Division 26 of this specification. 3/4" nominal trade conduit shall be installed. All cable must be neatly installed and adequately supported. When connecting to controllers, valves etc. that have no provisions for EMT connections, EMT may terminate in a junction box located within 36" of the controller or control valve. At every transition from cable tray to

conduit the ATC contractor will use insulation connectors or equivalent on the exposed end of the EMT to protect the cable from abrasion.

- D. All ATC rough-in boxes shall be identified with the letters "ATC" written across the inside of the box. In addition, each ATC cover plate shall be painted white with the letters "ATC" stenciled in black.

1.7 QUALITY ASSURANCE

- A. Provide an unconditional TWO-YEAR parts and service warranty. This warranty shall commence at the time of substantial completion of the various portions of the system.
- B. All parts and material and their installation methods shall be in accordance with the manufacturer's recommendations and specifications. All parts and material shall be new.
- C. The Contractor or firm executing the work of this section shall have at least 10 years experience in completing work of similar scope and nature to that specified.
- D. Emergency response by contractor shall be available 24 hrs/day 7 days/week 365 days/yr. Response time shall not be greater than 12 hours from time of call.
- E. 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.

1.8 SUBMITTAL AND TECHNICAL INFORMATION

- A. Submit shop drawings (6 sets) and manufacturer's data for the following items to the mechanical engineer:
 - o Wiring and installation diagrams.
 - o Valves
 - o Dampers
 - o Actuators
 - o Panels
 - o ATC device specification sheets
 - o Points list
 - o Control flow diagrams, complete with all control schematics and sequences of operation.
 - o Documentation of all software and hardware. These manuals shall be complete with installation procedures as well as start up and programming instructions. They should also contain any testing or maintenance procedures required to operate system on a continuing basis.

1.9 PROJECT COMPLETION REQUIREMENTS

- A. Upon completion of the project, the ATC contractor shall spend a minimum of 8 hours with the Ogden School District maintenance personnel to adequately instruct them on the operation and maintenance of the system. These training sessions shall be scheduled at times convenient to the School District and shall be conducted at the project.
- B. Provide (1) bound hard copy and (3) copies on CD Rom of the project Operating and Maintenance instruction manuals for use during the training sessions. Each manual shall contain all system components and DDC system programming.
- C. The ATC contractor shall provide as part of his contract the on-site services of a programmer familiar with the system for an additional 4 hours which the Engineer and/or the School District may use as they see fit to fine-tune or add features to the system.
- D. Operation & Maintenance Manuals: Provide 4 manuals in addition to those manuals specified above. These manuals shall provide descriptions of maintenance procedures for all system components, including sensors and controlled devices. They shall cover inspection, periodic preventative maintenance, fault diagnosis, and

repair or replacement of defective components. They shall include complete as-built ATC installation drawings with sequences of operation for all mechanical systems controlled by the ATC contractor. They shall each include both a hard copy & CD Rom of all as-built system programming.

2.0 EQUIPMENT

2.1 CONTROLLERS

- A. Schneider Electric LON or BACnet Controls as supplied and installed by UTAH YAMAS Controls with freely programmable controllers shall be utilized as indicated and specified elsewhere in this specification. Proprietary control system communication protocols will not be accepted.
- B. All main level controller inputs shall have at least 12 bit A/D converters for input accuracy. Less resolution is unacceptable for main level controllers or any controllers using an air monitoring station or monitoring building pressure. All main level controller outputs shall have board mounted hand-off-auto switches for local output override capability.
- C. The contractor shall utilize and employ only the following controllers for any central plant systems and air handling units. A single controller shall be designated with all programming and I/O for each system. This will allow stand alone equipment operation in the event of communications failure. Connection of multiple small controllers or combined operation with other programmable controllers on air handlers and central plant equipment is not permitted. All controllers shall be freely programmable; controllers with canned programming are not acceptable.
- D. Control systems shall consist of integration of the boiler control panel furnished by the boiler manufacturer for control and sequencing of the heating hot water boilers. Controls contractor shall interface and coordinate the installation of all boiler controls, pump start-stop and operation, control panels and energy management systems with the boiler manufacturer.

2.2 DDC INPUTS

- A. All DDC input devices shall provide industry standard signals and shall be compatible with the DDC controllers used.
- B. All temperature input devices shall have a rated accuracy of 1% or better.
- C. All pressure input devices shall have a rated accuracy of 2% or better. Pressure transmitters shall be selected to match the application, and shall not be damaged by pressures at five times the maximum measurable pressure.
- D. Miscellaneous input devices shall have accuracies as individually specified. All miscellaneous devices shall be specifically identified (with specifications) with submittals.
- E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

2.3 DDC OUTPUTS

- A. Modulating outputs shall be in accordance with industry standards and shall be compatible with the driven DDC devices.
- B. Outputs shall be 0-10 VAC/VOC or 0.5 sec - 5.0 sec. 4-20 MA.

- C. DDC digital outputs shall be either relay contact closures or Triacs rated for the application.

2.4 AUTOMATIC VALVES

- A. ATC valve bodies 2" and smaller shall be screwed with union; larger valve bodies shall be flanged. Screwed valves shall be rated at 150 psi or greater and shall have brass bodies. Flanged valves shall be rated at 250 psi or greater and have cast iron or steel bodies. All automatic valves shall be for DDC control application.
- B. All ATC valves including all 3-way valves shall fail Normally Open (N.O.)
- C. All heating and cooling valves shall fail Normally Open (N.O.)
- D. All valves shall be disc/plug and seat or ball valve construction.
- E. Shut-off pressure ratings of each valve shall be as required by the application.
- F. Valves shall be Belimo or Honeywell, M640001, M7400 series. (No substitutions)

2.5 MOTORIZED ATC DAMPERS

- A. Motorized control dampers shall be furnished by the Automatic Temperature Control Contractor for all relief, outside air and return air damper locations. Existing dampers shall be removed complete and replaced with new dampers. Dampers shall be factory-built, low leakage units such as Ruskin CD-50, Tamco or approved equal. Blades shall be 6" maximum width, 6063-T5 extruded aluminum width, 1/2" axles, and Oilite or Cycoloy bearings.
- B. All blade to blade linkages shall be external and accessible. No linkage within the damper frame channel will be accepted.
- C. Frames shall be 5" x 1", 6063-T5 extruded aluminum hat channel design, 0.125" minimum thickness with corner braces to assure squareness.
- D. Dampers shall be low leakage type with compressible end seals and neoprene or extruded vinyl blade and jamb seals. Leakage shall not exceed 6.2 cfm/sq. ft. at 4" W.G. Dampers shall require less than 7#-in/sq. ft. torque at the operating shaft for proper operation.
- E. Combustion air control dampers shall be opposed blade type.

2.6 DAMPER AND VALVE ACTUATORS

- A. Damper and valve actuators shall be of the gear-train type. All moving parts shall be permanently lubricated and not require addition or replacement of oil. Actuators shall meet the NEMA 3R rainproof rating and shall have an ambient temperature operating rating of -40°F to 140°F, without the addition of extra equipment. Actuators shall also carry the UL 94-5V rating for installation in return air plenums.
- B. Damper and valve actuators shall accept the appropriate Ma, VDC or digital output signals provided by the DDC controllers.
- C. Damper actuators shall be mounted outside the air stream whenever possible and be of sufficient size to operate the connected damper. Mount damper actuator on firm baseplate.
- D. Damper actuators linked to outdoor air dampers shall close their attached dampers upon power failure by means of a mechanical spring return.

- E. Actuator manufacturers shall be Belimo or Honeywell. No substitutions.

2.7 PRESSURE SENSORS

- A. All wet and dry pressure sensor transducers shall include a display indicating the pressure reading on the face of the transducer.

2.8 OUTSIDE AIR SENSOR

- A. The building shall use an outside air temperature reading as obtained from government operated web sites over an internet connection for accurately controlling mechanical equipment. The ATC contractor shall provide IP level devices, hardware and any software to permit the use of the outside air temperature from the government website. A backup sensor shall be installed at the building and shall be used whenever the internet outside air temperature reading is unavailable.

2.9 HOST COMPUTER

- A. The School District facility management and control system includes an existing Centralized Host computer currently located at the Ogden School District offices. Any networking, lines, and software shall be furnished and installed by Division 25 1000.
- B. The most current versions of all necessary controlling & monitoring software & graphic displays shall be installed on the District Centralized Host computer. Copies of all software, disks, operation manuals, along with installation instruction shall be provided to owner.
- C. All new software releases available within one year of the substantial completion date shall be provided to the owner and installed at no additional cost to the School District.
- D. The new controlling software data base for this project shall be constructed by the ATC contractor to Ogden School District requirements. Contractor shall consult with Ogden School District to verify these requirements as a part of this contract. Contractor shall provide a fully operational DDC control system that may be monitored, controlled & modified from the District Centralized Host computer. All control schedules, algorithms, and control logic shall be in place within each DDC controller and stored as back-up copies on both Host computers hard disks which may be down-loaded to individual DDC controllers as necessary. Documentation provided shall include block software flowchart showing the interconnection between each of the control algorithms and sequences. A hard copy paper printout of points for each device shall be provided. Copies shall be provided in O&M manual and CD Rom.
- E. The School shall be represented by complete graphical floor plans, with accurate locations of each major piece of HVAC equipment including all chillers, boilers, hot water heaters, pumps, emergency exhaust fan, valves, sensors and dampers. A zoom feature shall allow the operator to select any of the main systems, and see a graphical representation of the system with dynamic representation of all appropriate DDC input & output devices. Each major piece of HVAC equipment shall be graphically represented with all appropriate DDC points dynamically represented.
- F. Master DDC Control Panel:
 - 1. Extend from the existing Master DDC Control Panel or provide new as required.
The ATC contractor shall furnish and install a Network/Ethernet connecting device via District supplied network lines to the District host computer.

2.10 LOCAL DDC CONTROL PANELS

- A. Local DDC control panels shall be located inside the Boiler Room and Mechanical Rooms as necessary to provide both digital and analog input and output points as specified and/or required to achieve specified system performance and sequence of operation.
- B. Each local DDC control panel shall provide all control functions for the mechanical equipment specified to be controlled from that panel. Locate panels in a convenient and serviceable location.
- C. Every input and output point shall be well labeled and every digital output shall have a LED indication of the position of the output relay.
- D. ATC contractor shall provide documentation of the software application program for each digital controller.
- E. Documentation provided shall include block software flowchart showing the interconnection between each of the control algorithms and sequences. Complete ATC drawings including terminal connections shall be available at each local panel.
- F. System acceptance shall not be completed until this documentation is provided and located in each ATC interface panel.
- G. Systems providing modulating outputs via pulse width modulation techniques, shall provide within each ATC interface panel all the components required to implement the functions equivalent to an analog output.

2.11 ATC INTERFACE PANELS

- A. ATC interface panels shall be mounted near each group of local DDC controllers. Each panel shall be made of not less than 16 gage steel. Panel shall have a full back plate and full hinged door such that when the door is closed, the assembly provides a completely enclosed, NEMA 1 enclosure. Panels shall be fully painted and fitted with key locks. Appropriately sized nameplates shall be used to identify all panel mounted devices. Major wiring within panels shall install within distribution gutters (similar to Panduit). All wiring entering and leaving panels shall terminate on numbered terminal strips. All wiring within panels shall be color coded and the color shall not be changed between the terminal strip and the end destination of that wire. Panels shall contain wiring diagrams of the panel interior and associated devices. Diagrams shall identify all interior devices and shall include terminal numbers.
- B. Panels shall contain the following devices as applicable:
 - 1. Control transformers
 - 2. NEC required fusing
 - 3. Local DDC controllers (owner requirement)
 - 4. NEC required grounding
 - 5. Logic relays
 - 6. 120 VAC convenience outlet
 - 7. Control switches
 - 8. Pilot lights
 - 9. Terminal strips
 - 10. Status indicating lights

2.12 LABELING

- A. All ATC supplied panels and devices shall be permanently labeled with engraved plastic laminate labels indicating device name, system identifier and function within the system.

2.13 THERMOSTATS

- A. All ATC Room sensors shall be provided with digital readout that allow the user to view room temperature, adjust the room setpoint within preset limits and set desired override time. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow technician to balance HVAC zones and access any parameter in zone controller.

2.14 ROOFTOP UNIT APPLICATION CONTROLLERS:

- A. Provide one or more native BACnet application controllers for each roof top unit and provide native BACnet application controllers as needed for central plant control that adequately cover all objects listed in object list. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

PART 3 - EXECUTION

3.1 DEMOLITION

- A. Includes But Not Limited To: The removal of existing boiler, air handlers, hydronic pumps and pneumatic temperature controls systems inside the school complete. All existing pneumatic controllers, devices, sensors and controls are to be removed and replaced with new DDC controls.
- B. Where existing pneumatic temperature sensors or thermostats are removed, the existing wall boxes may be re-used.

3.2 SITE VERIFICATION

- A. Interface with other work and existing conditions. The ATC contractor, prior to bidding, shall visit the site to ascertain the existing control systems currently installed. The ATC contractor shall note which systems are to remain, systems which will require modifications and other items impacting the work of this section. The ATC contractor shall make necessary allowances in their bid for any removal, relocation and/or demolition of existing control systems as part of their bid

3.3 INSTALLATION

- A. Integrate the new chiller, boilers, pumps and other mechanical devices and equipment into the temperature control system serving the building. Verify location of new and existing control locations, and other required control sensors with sequences of operation and room details before installation. Install controls, sensors and devices as required to match system sequencing.
- B. Much of the work involved with this project will require access and work in confined spaces above ceilings and inside utility tunnels. The ATC contractor shall make necessary allowances in their bid for any removal, relocation and/or demolition of existing control systems and installation of new DDC control systems inside these confined spaces.
- C. Remove existing pneumatic controls, valves and pneumatic tubing at each convector, cabinet unit heater, hot water coil etc complete and replace with new DDC controls, valves, conduit and conductors for a complete and functional temperature control system.

- D. All heating hot water and chilled water DDC control valves at each coil shall be 3-way complete with bypass and balancing valve.
- E. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- F. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- G. Install electronic cables in EMT conduit where run in mechanical rooms, inside walls or above inaccessible ceilings or chases.
- H. Locate local DDC control panels in coordination with the School District Maintenance Supervisor. Install localized DDC control panels in Boiler Rooms, Mechanical Rooms and Custodial Service Rooms.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section " Conductors and Cables."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Field Verify that all new controls are fully functional with the new boilers, chiller, pumps and other mechanical heating and cooling devices; to provide for a complete and functional control system throughout the building. Verify operation of valve controls.
- C. Verify that the controls for the new boilers and pumps meet the requirements for the sequences of operation called for.

4.0 SEQUENCE OF OPERATION

4.1 EMERGENCY SHUTDOWN SWITCHES (Boilers B-1, B-2 and B-3 and WH-1 and WH-2)

- A. A remote mushroom type, single acting, manually reset, shutdown switch shall be located just inside each entry 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 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.

4.2 CARBON MONOXIDE (CO) EMERGENCY SHUTDOWN

- A. A carbon monoxide detection system consisting of sensors and control panel installed inside the boiler room shall sense carbon monoxide and shall shut down the boilers and water heaters in the event that carbon monoxide levels exceed 50 ppm inside the boiler room. The carbon monoxide detection system shall be interlocked with the building fire alarm system to activate the building fire alarm system in the event that CO levels exceed 50 ppm inside the boiler room.

4.3 HEATING HOT WATER HEATING SYSTEM CONTROL

- A. The building heating water heating system consists of two gas high efficiency boilers (B-1 and B-2), two variable speed building loop heating hot water pumps (P-3 & P-4) each driven by its own VFD.
- B. Boilers and associated pumps (P-3 & P-4) are enabled when OAT is less than 60 Deg F. (adjustable). Variable frequency building pumps shall be monitored and controlled by the DDC. HW supply and return temperature shall be monitored by a Stainless Steel temperature sensor mounted in a Stainless Steel thermal well.
- C. Boilers shall operate through their own control panel for optimization. DDC controls shall interface with the boiler control panel to provide for complete monitoring of the boilers.
- D. Pumps operate during the OCCUPIED and WARM-UP modes and are each rated at 100% of the building load. Pumps shall be operated via a system pressure differential switch. Location to be determined.
- E. When the panel mounted toggle HAND-OFF-AUTO (H-O-A) switches are in the AUTO position, these pumps will be controlled by the building energy management system. During the OCCUPIED or WARM-UP modes, if the outside temperature is below 72 degrees F.(adjustable), pump will start. Pumps shall lead/lag based on schedule from the DDC system.
- F. When the panel mounted toggle HAND-OFF-AUTO (H-O-A) switch is in the AUTO position, the boiler panel is enabled by the building management system. The boilers will be enabled whenever one or more of the heating pumps are running. Once enabled, the boilers operate from their own optimization control panel operating and safety controls.
- G. Once enabled the boilers shall be staged on a lead-lag basis through the building DDC system. The lead boiler shall automatically alternate every month. The lag boiler shall operate only when the lead boiler cannot maintain the desired hot water supply temperature per the outdoor air temperature reset schedule shown below. If for any reason the lead boiler fails, the lag boiler shall energize to maintain building water temperature.
- H. Each steam boiler shall have a isolation valve to prevent water flow from entering idle boilers. When boiler is enabled the isolation valve shall open to allow water to flow through the boiler. When boiler is idle, the isolation valve shall close.
- I. Terminal unit application controllers: (Coils, Convectors, Cabinet Heater & Unit Heater)

Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

- J. Heat Exchanger Control: The plate and frame heat exchanger shall operate with heating medium hot water. A water temperature sensor located in the heating hot water supply line shall operate the modulating control valve to maintain building supply water temperature (reset from outdoor temperature) as follows (adjustable):

Outdoor Air Temperature	Supply Water Temperature
70°F	90°F
0°F	180°F

- K. Static water pressure transmitters with pressure sensing taps located in both the heating water supply & return lines at locations approved by the Mechanical Engineer and acting through a DDC controller shall modulate the speed of the hot water pump(s) to maintain desired hot water system differential pressure. (Initial differential pressure setting shall be 10 psig) The first heating water pump shall start & run continuously when the outdoor air temperature is 75° F or lower (adjustable). The second pump shall start and run whenever the primary pump fails
- L. If a hot water pump is not running when commanded to do so by the DDC system, the other hot water pump shall automatically start & an alarm shall be sent to the DDC system.
- M. When water flow is detected by a paddle-type water flow switch located in the return water line to the heat exchanger the boiler control system shall be enabled.
- N. Interlock the boiler controls to allow operation only when water flow exists through the heating hot water piping as determined by a flow switch installed in the heating water piping.
- O. Provide interlocks with each 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.
- P. Provide analog temperature sensors in immersion wells in the the main supply and return water lines leaving the boiler room.
- Q. A local DDC controller with analog temperature sensors located in both the supply water and the outdoor air shall modulate hot water reset to maintain building supply water temperature (reset from outdoor temperature) as follows (adjustable):

Outdoor Air Temperature	Supply Water Temperature
70°F	90°F
0°F	180°F

- R. This sequence shall incorporate proportional plus integral (PI) control algorithms to minimize offset from setpoint.

4.4 DOMESTIC HOT WATER HEATING SYSTEM CONTROL

- A. The domestic hot water heating system shall operate through the DDC system to maintain domestic hot water temperature of 120 deg F to the school. Domestic hot water circulation pump (CP-1) shall operate whenever the DDC system enables the pump from a pre-set time schedule. The pump shall operate whenever return water temperature to the water heater is below 120 Deg F . A return water temperature sensor attached to the hot water recirculation pipe shall sense water temperature and start/stop the circulating pump accordingly.

4.5 CHILLED WATER SYSTEM CONTROL

- A. The chilled water system consists of a air cooled liquid, scroll compress chiller and chilled water pumps.
- B. Each pump shall run on a lead-lag basis. The local DDC controller shall alternate the lead pump on a monthly basis. If a pump does not run when it is commanded to do so, the lag pump shall start, and an alarm shall be sent to the DDC system.
- C. When pump starter mounted H-O-A switch is in the AUTO position, the pump shall be controlled by the DDC system.
- D. When the building is in the OCCUPIED mode and the outside air temperature is above 58°F (adjustable) the chilled water system shall be activated. The chilled water pump systems shall be started by the DDC system. When water flow has been proven by a paddle type sensor located in the chilled water return piping the chiller shall run under its factory furnished controls. Provide supply and return temperature sensors in the chilled water piping at the chiller, analog current sensors for pump and chiller compressors.
- E. When the building control system turns the chiller off the chilled water pump shall run for an additional five minutes and then stop.
- F. All control wiring for chilled water systems, chilled water control valves shall be provided and installed by ATC contractor as required for chillers provided.
- G. The DDC system shall control the chiller demand limit point. If the previous daily high outside air temperature is less than 80 degrees the DDC system shall limit the chiller operation to 50% capacity (adjustable) through the chiller demand point.

4.6 EXHAUST FANS

- A. The existing exhaust fans controlled by the pneumatic control system shall be integrated into the new DDC control system. Exhaust fans shall operate whenever the building is scheduled occupied.

4.8 GLYCOL FEED SYSTEM

- A. The ATC contractor shall provide all interlock and remote sensor wiring to provide a complete operational summer/winter glycol feed system. All equipment required shall be provided and installed by others. All wiring of GF-1 by ATC contractor.

- 4.9 TOILET ROOM EXHAUST FANS: Ceiling mounted, toilet room exhaust fans shall be individually switched with the light switch in the area served. In addition, each exhaust fan shall run for 10 minutes after the room lights have been turned off.
Roof mounted, toilet room exhaust fan fans shall be individually operated by pre-determined schedules from the building DDC system.

4.10 ACTUATORS AND VALVES

- A. The ATC contractor shall furnish a Freeze-stat and install "Hard Wire" interlock to disconnect the mechanical spring return actuator power circuit for fail-safe operation. Use of the control signal to drive the actuators closed is not acceptable.
- B. Each DDC analog output point shall have an actuator feedback signal, independent of control signal, wired and terminated in the control panel for true position information and troubleshooting. Or the actuator feedback signal may be wired to the DDC as an analog input for true actuator position status.
- C. Each Primary valve control shall be Analog (2-10vdc, 4-20ma). Actuators for Damper and Control Valves ½" to 6" shall be Electric unless otherwise specified, provide actuators as follows:
 - 1. UL Listed Standard 873 and Canadian Standards association Class 481302 shall certify Actuators.

2. NEMA 2 rated actuator enclosures are. Use additional weather shield to protect actuator when mounted outside.
3. 5 year Manufacturers Warranty. Two-year unconditional + Three year product defect from date of installation.
4. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
5. Position indicator device shall be installed and made visible to the exposed side of the Actuator. For damper short shaft mounting, a separate indicator shall be provided to the exposed side of the Actuator.
6. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for Butterfly Valve actuators.
7. A push button gearbox release shall be provided for all non-spring actuators.
8. Modulating actuators shall be 24Vac and consume 10VA power or less.
9. Conduit connectors are required when specified and when code requires it.

Damper Actuators:

Outside Air and Exhaust Air Damper Actuators shall be Mechanical Spring Return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.

Economizer Actuators shall utilize Analog control 2-10 VDC, Floating control is not acceptable.

Electric damper actuators shall be direct shaft mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or setscrew type fasteners are not acceptable.

One electronic actuator shall be direct shaft mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.

Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per damper section. (See below execution section for more installation details.)

Valve Actuators 1/2" to 6":

Mechanical spring shall be provided on all actuators for pre-heat coil and actuators for AHU or RTU heating or cooling coil when units are mounted outside. See plans for fail save flow function: Normal Open or Normal Closed. Capacitors or other non-mechanical forms of fail-safe are not acceptable.

All zone service actuators shall be non-spring return unless otherwise specified.

The valve actuator shall be capable of providing the minimum torque required for proper valve close off for the required application.

All control valves actuators shall have an attached 3-foot cable for easy installation to a junction box.

Override handle and gearbox release shall be provided for all non-spring return valve actuators.

Control Dampers. The sheet metal contractor shall furnish and size all automatic control dampers unless

provided with packaged equipment. The sheet metal contractor shall install all dampers unless provided with packaged equipment.

1. All dampers used for modulating service shall be opposed blade type arrange for normally open or normally closed operation as required. The damper is to be sized so that when wide open the pressure drop is a sufficient amount of its close-off pressure drop for effective throttling.
2. All dampers used for two-position or open-close control shall be parallel blade type arranged for normally open or closed operation as required.
3. Damper linkage hardware shall be constructed of aluminum or corrosion resistant zinc & nickel-plated steel and furnished as follows:
4. Bearing support bracket and drive blade pin extension shall be provided for each damper section. Sheet metal contractor shall install bearing support bracket and drive blade pin extension. Sheet metal contractor shall provide permanent indication of blade position by scratching or marking the visible end of the drive blade pin extension.
5. Drive pin may be round only if V-bolt and toothed V-clamp is used to cause a cold weld effect for positive gripping. For Single bolt or set-screw type actuator fasteners, round damper pin shafts must be milled with at least one side flat to avoid slippage.
6. Damper manufacturer shall supply alignment plates for all multi-section dampers.

Control Valves ½" to 6": The BAS contractor shall furnish all specified motorized control valves and actuators. BAS contractor shall furnish all control wiring to actuators. The Plumbing contractor shall install all valves. Equal Percentage control characteristic shall be provided for all water coil control valves. Linear valve characteristic is acceptable for 3-way valves 2½ inch and above.

1. Characterized Control Valves shall be used for hydronic heating or cooling applications and small to medium AHU water coil applications to 100GPM. Actuators are non-spring return for terminal unit coil control unless otherwise noted. If the coil is exposed to the Outside Air stream then see plans for Spring Return requirement.

4.11 MULTI-ZONE FAN SYSTEMS

- A. Fan systems each consist of a 2-deck multi-zone system with constant speed supply fan. Supply fan shall be driven by a VFD, a heating coil and cooling coil, filters, and outdoor air, relief air, and return air dampers.
- B. Install smoke detectors in the supply and return air stream of each unit in compliance with NFPA 90A, and wire to stop the unit fan upon activation. Detectors furnished under Division 26 0000.
- C. Provide a factory mounted and wired standalone DDC Control system to control each air handling unit. All wiring shall be installed in minimum ¾" EMT conduit by ATC Contractor. See this section for additional requirements. These controllers shall be electronic using proportional plus integral control algorithms to modulate the dampers and valves in accordance with the following sequence:
 1. In the unoccupied mode, the fan will remain off, the outside air damper will remain closed and the return air damper will remain open. The position of the zone dampers will be determined by the relationship of the occupied space setpoint and the space temperature in the respective zones. If any space temperature falls below 60° (adjustable), the fan will be started and shall run continuously until the space temperature has increased to 63°.

In the occupied mode, the fan will run continuously. The zone dampers will be controlled by their respective zone temperature sensors and setpoints. Zone dampers will modulate to provide any mix of hot deck and bypass air from 100% hot and 0% bypass, to 0% hot and 100% bypass and on a greater call for cooling,

dampers will provide any mix of bypass and on a greater call for cooling, dampers will provide any mix of bypass and cold deck air as required by the space.

The cold deck temperature will be controlled by operating a modulating 3-way chilled water mixing valve (valve will provide constant flow to the chiller by bypassing and or flowing the chilled water coil) in response to the requirements of the zone with the greatest call for cooling. If no zone has a space temperature warmer than its setpoint, the mixed air system will remain closed to the outside air, unless there is a higher than setpoint, CO2 condition.

The hot deck temperature will be controlled by operating a modulating hot water valve, in response to the requirements of the zone with the greatest call for heat. If there is a call for heating, the hot deck temperature will be controlled on an adjustable reset schedule (i.e.: OAT 60°, hot deck 70°. OAT 0°, hot deck 140°).

Furnish new room zone sensors for all zones

- D. The mixed air temperature will have a low limit of 55° (adjustable), which will modulate the mixed air dampers back toward open return air and closed outside air as required to prevent the mixed air from becoming colder than the low limit setting. When the outside air temperature is greater than the return air temperature (i.e.: 78°), the outside damper will close, and the return air damper will open. There will be a CO2 transmitter located in the space served by this unit. When the CO2 count becomes greater than the setpoint (adjustable), the mixed air dampers will modulate toward an open outside air damper and closed return air damper position. The outside air damper will only be allowed to move toward open when the fan is operating and in the occupied mode. Outside air damper will spring closed when the supply fan stops. The relief air fan VFD shall be indexed on when the exhaust damper opens to a selectable position. Exhaust damper will open when the outside air damper opens selectable position. The exhaust damper will fail closed.
- E. The space temperature set points shall be on-line changeable by an operator and shall initially set at 74° F.
- F. The fan shall start and stop based on a seven-day schedule plus a three-hour override schedule. The units shall be indexed on via remote override from each zone sensor. The length of override shall be user selectable. Sequence shall incorporate an optimum start routine that will start the unit prior to the occupied time to ensure that the desired average space temperature of 74° F. is achieved at occupied time. If the average zone temperature is less than 72° F. and the outside air temperature is less than 80° F., the unit will be indexed into morning warm-up. During morning warm up, the outside air damper will remain closed until scheduled occupied time. If the outside air temperature is greater than 80° F. the outside air damper will modulate to a minimum position.
- G. An alarm point shall be provided for loss of status on each fan.
- H. Whenever heating valve is not closed or when outdoor air temperature exceeds 76° F, the outside air and relief air dampers shall close to the minimum position as determined by the return duct CO2 level transmitter and minimum ventilation requirements.
- I. The outside air, relief air and return air dampers shall sequence as follows:
 - 1. When no outside air is required, the outside air dampers & relief air dampers shall be shut, and the return air dampers shall be 100% open.
 - 2. As outside air is required by the air handler for minimum outside air or economizer purposes, the outside air dampers shall begin to modulate open. During this time the return air dampers shall modulate opposite of the relief air dampers & the relief air damper shall modulate as required to maintain required building static pressure.
 - 3. At 50% outside air flow, both the outside air dampers and the return air dampers shall be 50% open & the relief air damper % open shall match outside air damper, or as required to maintain required building static pressure.

4. As more than 50% outside air flow is required, the outside air dampers shall modulate to 100% open and the return air dampers shall begin to modulate closed.
 5. Relief air damper shall track opposite of outside air damper to 100% open, or as required to maintain required building static pressure.
 6. Relief air fan shall energize when required to maintain required building static pressure (adjustable) relief fan is operated via a VFD provided with unit.
 7. The reverse shall occur as less outside air is required.
- J. A CO2 level transmitter located in the return air duct, acting through a DDC controller, shall reset the outside air damper minimum position. The amount of reset action shall be adjustable and subject to a maximum of 25% minimum outdoor air.
- K. An averaging style mixed air temperature sensor, acting through a DDC controller, shall provide 48°F (adjustable) mixed air temperature low limit control of the air handling system.
- L. If mixed air temperature drops below 39°F (adjustable) as sensed by an electrically interlocked averaging style freeze stat, supply and relief fans shall stop, outdoor and relief air dampers shall close and an alarm shall be sent to both the local and District Offices Host Computers.
- M. A -0.25 to 0.25 "w.c. static pressure transmitter with an outside probe, must be a Dwyer A306, and an interior probe strategically located in an interior hallway in area served by the correct fan system, acting through the DDC system shall modulate the relief dampers and return fan VFD in sequence to maintain 0.04 "w.c. building static pressure. Individual control of the supply and return fan speeds shall be achievable by the DDC system controller.
- N. A temperature sensor shall be located inside of the building under each relief damper and within 4 feet of its opening to the outside. This temperature sensor shall be included as a low building space temperature reading. During extreme weather conditions this sensor is intended to prevent pipes and other equipment in the building from freezing. If any of these sensors fall below 50 degrees in the unoccupied mode, the fan system shall start to supply warm air to the plenum. Also, if any of the sensors fall below 35 degrees (adjustable) the relief dampers shall be commanded closed.
- O. The DDC system shall also provide negative building pressure control for the space that it serves. If the building static pressure begins to fall below the minimum building static pressure set point of 0.01 " w.c., the controller shall send a signal to the outside air dampers to open to allow negative building pressure control.
- P. UNOCCUPIED mode: The lowest space temperature sensor served by the air handler, acting through a DDC controller, shall cycle the supply fan with the heating valve open 100% to maintain desired minimum space temperature. Outdoor air & relief dampers shall remain closed. Chilled water valve shall close to the coil when the supply fan is not running.
- Q. Provide the network capability to the stand alone DDC packages.
- R. The controller shall be software or firmware programmable and shall incorporate all software or firmware necessary for the following function:
1. Interfacing of the instrumentation and final control elements such that a DDC monitoring and control capability compatible with the School District's existing EMS system is provided.
 2. Execution of resident application programs.
 3. Execution of sequences of operations for equipment controlled.
 4. Communication with other controllers.

BUILDING DDC SYSTEM INPUT/OUTPUT POINT SUMMARY:

The ATC contractor shall furnish and install all DDC controllers, sensors, interface relays, wiring and other field accessories for the DDC system to provide for implementation of the above sequences of operation and including the input-output points listed below. All points shall be displayed on password-protected graphic screens on both the existing District host computer and the man-machine interface or Host computer located in the Main Custodial office.

DIGITAL OUTPUTS:

CHILLERS (each individual compressor)	START-STOP
CHILLED WATER PUMPS (each pump)	START-STOP
MAIN HEATING PUMPS (each pump)	START-STOP
110° F CULINARY SYSTEM	ENABLE-DISABLE
140° F CULINARY SYSTEM	ENABLE-DISABLE
FUTURE USE BY OWNER (6 outputs)	

DIGITAL INPUTS:

CHILLER (each individual compressor)	RUN STATUS
CHILLER FAILURE ALARM (each chiller)	SAFETY SHUTDOWN
CHILLED WATER FLOW (each chiller)	STATUS
BOILER HOT WATER (EACH BOILER)	FLOW
CONTROL VALVES	STATUS
HEATING WATER PUMPS VFD	STATUS
HEATING WATER PUMPS VFD	FAULT
CHILLED WATER PUMPS	STATUS
CHILLED WATER PUMPS	FAULT
DOMESTIC WATER FLOW	STATUS
CHILLER DEMAND LIMITING	STATUS
FUTURE USE BY OWNER (4 inputs)	

ANALOG INPUTS:

CHILLED WATER SUPPLY	TEMP
CHILLED WATER RETURN	TEMP
HOT WATER SUPPLY	TEMP
HOT WATER RETURN	TEMP
CULINARY 120° F STORAGE TANK	TEMP
CULINARY 140° F STORAGE TANK	TEMP
BOILER (EACH BOILER)	PRESS
OUTDOOR	TEMP

ANALOG OUTPUTS:

HEATING PUMP SPEED	0-10 VDC OR PWM
FUTURE USE BY OWNER (4 OUTPUTS)	0-10 VDC OR PWM

END OF SECTION 25 1000

SECTION 26 0500

ELECTRICAL GENERAL PROVISIONS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.

1.2 DESCRIPTION OF WORK:

- A. The extent of electrical work is indicated on drawings and/or specified in Divisions 26, 27 and 28 sections of the specification. Provide all labor, materials, equipment, supervision and service necessary for a complete electrical system. Work includes, but is not necessarily limited to, the following items.

	<u>ITEM</u>	<u>SECTION</u>
1.	Electrical General Provisions	26 0500
2.	Electrical Submittals and Spare Parts	26 0502
3.	Electrical Connections for Equipment	26 0507
4.	Conductors and Cables	26 0519
5.	Grounding	26 0526
6.	Supporting Devices	26 0529
7.	Conduit Raceway	26 0532
8.	Electrical Boxes and Fittings	26 0533
9.	Electrical Seismic Control	26 0548
10.	Electrical Identification	26 0553
11.	Switchgear and Switchboards	26 2413
12.	Panelboards	26 2416
13.	Service Entrance	26 2713
14.	Wiring Devices	26 2726
15.	Overcurrent Protective Devices	26 2815
16.	Motor and Circuit Disconnects	26 2816
17.	Motor Starters	26 2913
18.	Demolition	26 4119

- B. Use of standard industry symbols together with the special symbols, notes, and instructions indicated on the drawings describe the work, materials, apparatus and systems required as a portion of this work.
- C. Visit the site during the bidding period to determine existing conditions affecting electrical and other work. All costs arising from site conditions and/or preparation shall be included in the base bid. No additional charges will be allowed due to inadequate site inspection.

1.3 DEFINITION OF TERMS

- A. The following terms used in Divisions 26, 27 and 28 documents are defined as follows:
 - 1. "Provide": Means furnish, install and connect, unless otherwise indicated.
 - 2. "Furnish": Means purchase and deliver to project site.
 - 3. "Install": Means to physically install the items in-place.

4. "Connect": Means make final electrical connections for a complete operating piece of equipment.

1.4 RELATED SECTIONS:

- A. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
- B. General and Supplementary Conditions: Drawings and general provisions of contract and Division 1 of the Specifications, apply to all Division 26, 27 and 28 sections.
- C. Earthwork:
 1. Provide trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, buried cable, in-grade pull boxes, manholes, lighting pole foundations, etc. See Division 31, Sitework, and other portions of Divisions 26, 27 and 28, for material and installation requirements.
- D. Concrete Work:
 1. Provide forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, light pole foundations, pull box slabs, vaults, equipment pads, etc. See Division 3, Concrete for material and installation requirements.
- E. Miscellaneous Metal Work:
 1. Provide fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, lighting fixtures, panelboards, distribution boards, switchboards, motor controls centers, etc. See Division 5, Metals for material and installation requirements.
- F. Miscellaneous Lumber and Framing Work:
 1. Provide wood grounds, nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment. See Division 6, Rough Carpentry for material and installation requirements.
- G. Moisture Protection:
 1. Provide membrane clamps, sheet metal flashing, counter flashing, caulking and sealants as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors and ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vapor tight. See Division 7, Thermal and Moisture Protection for material and installation requirements.
- H. Access panels and doors:
 1. Provide in walls, ceiling, and floors for access to electrical devices and equipment. See Division 8, Doors and Windows for material and installation requirements.
- I. Painting:
 1. Provide surface preparation, priming and finish coating as required for electrical cabinets, exposed conduit, pull and junction boxes, poles, surface metal raceways, etc. See Division 9, Finishes for material and installation requirements.

1.5 WORK FURNISHED AND INSTALLED UNDER ANOTHER SECTION REQUIRING CONNECTIONS UNDER THIS SECTION:

- A. Provide electrical service, make requisite connections and perform operational test. Items furnished and installed under other sections and connected under this section, include but are not limited to the following:
 1. Electric motors.
 2. Package mechanical equipment: fans, fan coil units, pumps, boilers, duplex compressors, etc.

3. Temperature control panels.
4. Variable frequency controllers.
5. Chiller starters.

1.6 WORK NOT INCLUDED IN THIS DIVISION:

- A. Items of work provided under another contract include, but are not necessarily limited to, the following:
1. Telephone cables and electronic equipment.
 2. Data system cables, fittings, coverplates and electronic equipment.
 3. Control wires for irrigation control valves.
 4. Energy management/temperature control system; both line and low voltage including conductors and conduit.
 5. Television monitors and projection equipment.
 6. Security system equipment, cables, fittings, and coverplates.
 7. CCTV cabling and electronic equipment.
 8. MATV cabling and electronic equipment

1.7 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS:

- A. Before bidding, Contractor shall familiarize himself with the drawings, specifications and project site. Submit requests for clarification to Architect/Engineer in writing prior to issuance of final addendum. After signing the contract, the Contractor shall meet the intent, purpose, and function of the Contract Documents. Any costs of materials, labor and equipment arising therefrom, to make each system complete and operable, is the responsibility of the Contractor.

1.8 QUALITY ASSURANCE:

- A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies refers to the latest edition of such publications adopted and published prior to submittal of the bid proposed, unless noted otherwise herein. Such codes or standards are considered a part of this specification as though fully repeated herein.
- B. When codes, standards, regulations, etc. allow work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred as reducing the quality, requirements or extent of the Drawings and Specifications. Perform work in accordance with applicable requirements of all governing codes, rules and regulations including the following minimum standards, whether statutory or not:
1. National Electric Code (NEC).
 2. International Building Code (IBC).
 3. International Fire Code (IFC).
 4. International Mechanical Code (IMC).
- C. Standards: Comply with the following standards where applicable for equipment and materials specified under this Division.
- | | | |
|----|-------|--|
| 1. | UL | Underwriters' Laboratories |
| 2. | ASTM | American Society for Testing Materials |
| 3. | CBN | Certified Ballast Manufacturers |
| 4. | IPCEA | Insulated Power Cable Engineers Association |
| 5. | NEMA | National Electrical Manufacturer's Association |
| 6. | ANSI | American National Standards Institute |
| 7. | ETL | Electrical Testing Laboratories |
- D. All electrical apparatus furnished under this Section shall conform to (NEMA) standards

and the NEC and bear the Underwriters' Laboratories (UL) label where such label is applicable.

- E. Comply with requirements of State and Local Ordinances. If a conflict occurs between these requirements and the Contract Documents, the most stringent requirements shall govern. The Contractor accepts this responsibility upon submitting his bid, and no extra charge will be allowed after the contract is awarded. This shall not be construed as relieving the Contractor from complying with any requirements of the Contract Documents that may be in excess of the aforementioned requirements, and not contrary to same.
- F. Obtain all permits, inspections, etc. required by authority having jurisdiction. Include all fees in bid. Furnish a certificate of approval to the Owner's Representative from the Inspection Authority at completion of the work.
- G. Employ only qualified craftsmen with at least three years of experience. Workmanship shall be neat, have a good mechanical appearance and conform to best electrical construction practices. Provide a competent superintendent to direct the work at all times. Any person found incompetent shall be discharged from the project and replaced by satisfactory personnel.
- H. Contractor shall have a current state contracting license applicable to type of work to be performed under this contract.

1.9 CONSTRUCTION CHANGE ORDER PROPOSALS

- A. In the event that a submission of a change order is issued by the contractor, the following information will be required to be submitted by the contractor, prior to any consideration by the owner/architect.
 - a. Where project manager or project engineer work is required, the labor cost shall not exceed 2% of the electrical portion of the change order.
 - b. All equipment, including conduit and wire, shall be itemized, identifying unit costs and quantities of equipment. Distributor quotes shall accompany all change order requests. The distributor quotes shall include costs for all equipment including conduit and wire. Lot pricing for equipment is not acceptable.
 - c. The general contractor shall review and confirm that the quantity and costs of materials submitted appear reasonable for the scope proposed.
 - d. Labor units shall not exceed base NECA #1 standards. No adjustment factors shall be approved.
 - e. Any research and labeling time, shall be the responsibility of the electrical contractor and shall not be included in the change order request.
 - f. Any costs associated with the purchase of tools or transportation shall be fully itemized for review by architect/owner.
 - g. Overtime rates shall only be approved where additional manpower cannot achieve the same result.
 - h. Change order form shall follow the following format:
 - i. PCO number
 - ii. Detailed description of work being performed
 - iii. Location on project where work is performed
 - iv. Chosen NECA column
 - v. Identified material:
 - 1. QTY
 - 2. Unit cost
 - 3. Mark up
 - 4. Material total
 - vi. Identified labor:
 - 1. QTY
 - 2. Unit cost
 - 3. Composite labor rate
 - 4. Labor total

1.10 RECORD DRAWINGS:

- A. Maintain, on a daily basis, a complete set of "Record Drawings", reflecting an accurate record of work in accordance with the following:
 - 1. Show the complete routing and location of all feeders rated 100 amps and larger. Locate work buried below grade or under slab, work concealed above ceilings, and work in concealed spaces, dimensionally from fixed structural elements (not partition walls, etc.)
 - 2. Show the complete routing and location of all telecommunications conduits, systems raceways, and empty raceways, 1-1/4" and larger. Locate work buried below grade or under slab, work concealed above ceilings, and work in concealed spaces, dimensionally from fixed structural elements (not partition walls, etc.).
 - 3. Show all changes, deviations, addendum items, change orders, job instructions, etc., that change the work from that shown on the contract documents, including wall relocations, fixtures and device changes, branch circuiting changes, etc. Where locations of boxes, raceways, equipment, etc. are adjusted in the field to fit conditions, but such new locations may not be obvious by referring to the contract document, show new locations on the record drawings.
- B. At the discretion of the Architect/Engineer, the drawings will be reviewed on a periodic basis and used as a pre-requisite for progress payments. This requirement shall not be construed as authorization for the Contractor to make changes in the layout, or work without written authorization for such changes. The "Record Drawings" for daily recording shall consist of a set of blue line prints of the Contract Drawings.
- C. Upon completion of the work, purchase a complete set of electronic drawings. Transfer all "Record" information from the blue line prints to the drawings via the current CAD program that it was written. The Architect/Engineer shall review the drawings and the Contractor shall incorporate the resulting comments into the final record drawings. The Contractor shall make two complete copies of the drawings electronically and forward this to the Engineer.
- D. Certify the "Record Drawings" for correctness by placing and signing the following certifications of the first sheet of the drawings:

"CERTIFIED CORRECT (3/8" high letters)

(Name of General Contractor)

By: _____ Date: _____

(Name of Electrical Contractor)

By: _____ Date: _____

1.11 GUARANTEE:

- A. Ensure that electrical system installed under this contract is in proper working order and in compliance with drawings, specifications, and/or authorized changes. Without additional charge, replace any work or materials that develop defect, except from ordinary wear and tear, within one year from the date of substantial completion. Exception: Incandescent and fluorescent lamps shall be guaranteed for a period of two months from the date of substantial completion.

1.12 OTHER:

- A. Right to Hire. "Client" agrees that during the project and for a period of twenty four (24) months following substantial completion that it will not, directly or indirectly, employ or solicit to employ BNA Personnel.

PART 2 – PRODUCTS

2.1 GENERAL:

- A. Products are specified by manufacturer name, description, and/or catalog number. Discrepancies between equipment specified and the intended function of equipment shall be brought to the attention of the Architect/Engineer in writing prior to bidding. Failure to report any conflict, including catalog numbers, discontinued products, etc., does not relieve the Contractor from meeting the intent of the contract documents nor shall it change the contract cost. If the Contractor is unable to interpret any part of the plans and/or specifications, or should he find discrepancies therein, he shall bring this to the attention of the Architect/Engineer who will issue interpretation and/or additional instructions to Bidders before the project is bid.

2.2 MANUFACTURERS:

- A. Provide products of manufacturers specified. Manufacturers catalog numbers and descriptions establish the quality of product required. Substitutions will be considered if a duplicate written application (2-copies) is at the office of the Architect/Engineer eight (8) working days prior to the day of the bidding. The application shall include the following: 1) A statement certifying that the equipment proposed is equal to that specified; that it has the same electrical and physical characteristics, compatible dimensions, and meets the functional intent of the contract documents; 2) The specified and submittal catalog numbers of the equipment under consideration; 3) A pictorial and specification brochure.
- B. Any conflict arising from the use of substituted equipment shall be the responsibility of the Contractor, who shall bear all costs required to make the equipment comply with the intent of the contract documents.
- C. Samples may be required for non-standard or substituted items before installation during construction. Provide all samples as required.
- D. No materials or apparatus may be substituted after the bid opening except where the equipment specified has been discontinued.
- E. Provide only equipment specified in the Contract Documents or approved by addendum.

2.3 SPARE PARTS:

- A. Provide spare parts (fuses, diffusers, lamps, etc.) as specified. Transmit all spare parts to Owner's Representative prior to substantial completion.

PART 3 – EXECUTION

3.1 INSTALLATION:

- A. Layout electrical work in advance of construction to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary for proper installation; perform with care. Use skilled mechanics of the trades involved. Repair damage to building and equipment at no additional cost to the contract. Cutting work of other Contractors shall be done only with the consent of that Contractor. Cutting structural members shall not be permitted.
- B. Provide equipment enclosures appropriate to the environment to which they are installed. For example, provide NEMA 3R for exterior enclosures and NEMA 1 for interior enclosures unless otherwise noted.
- C. Since the drawings of floor, wall, and ceiling installation are made at small scale; outlets, devices, equipment, etc., are indicated only in their approximate location unless dimensioned. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned, and coordinate such locations with work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings, but

refer to the architectural and mechanical shop drawings and project drawings for dimensions as applicable.

- D. Perform for other trades, the electrical wiring and connection for all devices, equipment or apparatus. Consult Architectural, Mechanical, and other applicable drawings, and all applicable shop drawings to avoid switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc., or from being located in chalkboards, tackboards, glass panels, etc. Relocate buried electrical devices and/or connections as directed at no additional cost.
- E. Coordinate the location of outlets, devices, connections, and equipment with the supplier of the systems furniture prior to rough-in.
- F. Where conduit, outlets or apparatus are to be encased in concrete, it must be located and secured by a journeyman or foreman present at the point of installation. Check locations of the electrical items before and after concrete and/or masonry installation and relocate displaced items.
- G. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.

3.2 CLEAN:

- A. Clean up all equipment, conduit, fittings, packing cartons and other debris that is a direct result of the installation of the work of this Division.
- B. Clean fixtures, interiors and exteriors of all equipment, and raceways. Replace all filters in electrical equipment upon request for Substantial Completion.

3.3 POWER OUTAGES:

- A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the Owner. Include all costs for overtime work in bid.
- B. Submit written request at least 7 days in advance of scheduled outage and proceed with outage only after receiving authorization from the Owner's Representative.
- C. Keep all outages to an absolute minimum.

3.4 STORAGE AND PROTECTION OF MATERIALS:

- A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work underway, and apparatus against loss or damage.

3.5 EXCAVATING FOR ELECTRICAL WORK:

- A. General: Locate and protect existing utilities and other underground work in manner that will ensure that no damage or service interruption will result from excavating and backfilling. Perform excavation in a manner that protects walls, footings, and other structural members from being disturbed or damaged in any way. Burial depths must comply with NEC Section 300-5 (or State of Utah requirement, whichever is more stringent), unless noted otherwise on drawings.
- B. Protect persons from injury at excavations, by barricades, warnings and illumination.
- C. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.
- D. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install electrical work on frozen excavation bases or sub-bases.

- E. Do not excavate for electrical work until the work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum. See other sections of specification for additional requirements for excavating.
- F. Store excavated material (temporarily) near excavation, in a manner that will not interfere with or damage excavation or other work. Do not store under trees (within drip line).
- G. Retain excavated material that complies with requirements for backfill material. Dispose of excavated material that is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material. Remove unused material from project site, and dispose of in lawful manner.

3.6 BACKFILL MATERIALS:

- A. For buried conduit or cable (other than below slab-on-grade, or concrete encased) - 2" thickness of well graded sand on all side of conduit or cable.
- B. For trench backfill to within 6" of final grade - soil material suitable for compacting to required densities.
- C. For top 6" of excavation - Top soil.
- D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (percent of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.
 - 1. Lawn/Landscaped Areas: 85 percent for cohesive soils, 95 percent for cohesionless soils.
 - 2. Paved Areas, Other than Roadways (90 percent for cohesive soils, 95 percent for cohesionless soils).
- E. Subsidence: Where subsidence is measurable or observable at electrical work excavations during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of the surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.7 CONCRETE BASES:

- A. Unless otherwise noted, provide 4" high reinforced concrete bases for all floor mounted or floor standing electrical equipment, including generators, transformers, switchgear, battery racks, motor control centers, etc. Extend bases 6" beyond equipment or mounting rails on all sides or as shown on the drawings. Notwithstanding this requirement, coordinate with equipment manufacturer, shop drawings, and height of base to ensure compliance with NEC 404.8.
- B. Concrete bases shall be provided under Divisions 26, 27 and 28. Coordinate size and location of all bases and furnish all required anchor bolts, sleeves, reinforcing and templates as required to obtain a proper installation.

3.8 ROOF PENETRATIONS:

- A. Where raceways penetrate roofing or similar structural area, provide appropriate roof jack coordinate with the roofing contractor and the Architect in order to match the vent with the roof construction. The jack shall be sized to fit tightly to raceway for weather-tight seal, and with flange extending a minimum of 9" under roofing in all sides or as required by the roof type of construction. Completely seal opening between inside diameter of roof flashing and outside diameter of penetrating raceways. Coordinate all work with work required under roofing section of specifications.

3.9 FIRE PENETRATION SEALS:

- A. Seal all penetrations for work of this section through fire rated floors, walls and ceilings to

prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after fire. The fire rating of the penetration seal shall be at least that of the floor, wall or ceiling that it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electrical Code. Where applicable, provide OZ Type CFSF/I and CAFSF/I fire seal fittings for conduit and cable penetrations through concrete and masonry walls, floors, slabs, and similar structures. Where applicable, provide 3M CID cast-in device for floor slabs. Where applicable, provide 3M fire barrier sealing penetration system, and/or IPC Flame Safe Fire Stop System, and/or Chase Foam fire stop system, including wall wrap, partitions, caps, and other accessories as required. All materials to comply with UL 1479 (ASTM E-814). Comply with manufacturer's instructions and recommendations for installation of sealing fittings and barrier sealing systems.

3.10 PROJECT FINALIZATION AND START-UP:

- A. Upon completion of equipment and system installation, assemble all equipment Factory Representatives and Subcontractors for system start-up.
- B. Each Representative and Subcontractor shall assist in start-up and check out their respective system and remain at the site until the total system operation is accepted by the Owner's representative.
- C. The Factory Representative and/or System Subcontractor shall give personal instruction on operating and maintenance of their equipment to the Owner's maintenance and/or operation personnel. To certify acceptance of operation and instruction by the Owner's Representative, the contractor shall prepare a written statement as follows:
 - 1. This is to certify that the Factory Representative and System Subcontractor for each of the systems listed below have performed start-up and final check out of their respective systems.
 - 2. The Owner's Representative has received complete and thorough instruction in the operation and maintenance of each system.

SYSTEM	FACTORY REPRESENTATIVE
(List systems included)	(List name and address of Factory Representative)

Owner's Representative

Contractor

- D. Send copy of acceptance to Architect/Engineer.

3.11 FINAL REVIEW:

- A. At the time of final review, the project foreman shall accompany the reviewing party, and remove coverplates, panel covers and other access panels as requested, to allow review of the entire electrical system.

END OF SECTION 26 0500

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SECTION 26 0502

ELECTRICAL SUBMITTALS, O & M MANUALS AND SPARE PARTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to all Division 26, 27 and 28 sections.
- B. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.
- C. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 SUBMITTAL REQUIREMENTS:

A. GENERAL:

- 1. After the Contract is awarded but prior to ordering, manufacture, or installation of any equipment, prepare complete Submittals including shop drawings, product data, brochures, etc. for materials and equipment as required by each section of the specification.
- 2. Review of Submittals shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from the Contract Document's requirements. It shall be clearly understood that the noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Document's shall govern and are not waived, or superseded in any way by the review of the Shop Drawings and Brochures.
- 3. Submittals are reviewed, not approved. Comments made within submittals do not alter the contract documents in any way. The contractor is still responsible, regardless of comments (if any) made within submittals, for complying with drawings and specifications.
- 4. Notify engineer in writing if any of the comments noted in the submittals alter the contract cost. A comment within the submittal process which increases/decreases cost of product is not an authorization to the contractor under any circumstances to proceed.
- 5. Notify engineer of any modifications between contract documents and submittals. It is the responsibility of the contractor to ensure compliance.
- 6. ELECTRONIC SUBMITTAL REQUIREMENTS:
 - a. Provide submittals in Portable Document Format (PDF).
 - b. Documents must be electronically bookmarked by Division e.g. 26, 27 and 28, Specification section e.g. 26 0510 and individually for each item submitted for light fixtures, switchgear, transformer, panelboard etc. and keyword searchable using Adobe Acrobat (<http://www.adobe.com/acrobat>) or Bluebeam Revu (<http://www.bluebeam.com>) for each relevant section.

- c. Electronically highlight all options for light fixtures, electrical equipment, etc. Manual highlighting and scanning of the documents is NOT acceptable and will NOT be reviewed.
- d. Provide only completed cutsheets for all fixture and equipment types. Blank cutsheets submitted with a schedule are NOT acceptable and will NOT be reviewed.
- e. At the time of submission, the electrical contractor shall provide a complete and comprehensive submission of all required specification sections/shop drawings at the same time. Exceptions may be given, with prior approval, for time-sensitive equipment.
- f. A maximum of one submittal per specification section is allowed. It is NOT acceptable to provide a product by product submittal. Single product by product submittals will NOT be reviewed.

B. SCHEDULING

1. GENERAL

- a. A minimum period of two weeks, exclusive of transmittal time, will be required each time Submittals are submitted or resubmitted for review. This time period shall be considered by the Contractor when scheduling submittal data.
- b. If the shop drawings are rejected twice, the contractor shall reimburse the engineering firm the sum of \$1,200.00 for the third review and any additional reviews required prior to the commencement of additional review.

C. QUALITY ASSURANCE

1. PRE-SUBMITTAL PREPARATION

- a. Prior to submission of the Shop Drawings and Project Data, review and certify that they are in compliance with the Contract Documents. Verify all dimensional information to ensure proper clearance for installation of equipment.
- b. Shop drawings requiring the use of electronic documents (floor plans, Lighting plans, fire alarm plans, etc.) shall be requested via a request for information (RFI) through the general contractor. Electronic documents will be provided to the Architect for distribution. No direct vendor requests will be accepted.
- c. Contractor is completely responsible for the content of the submittal

2. SUBMITTAL REQUIREMENTS

- a. Provide a stamp or statement on each submittal as follows:
 - i. I hereby certify that this Shop Drawing and/or Brochure has been checked prior to submittal and that it complies in all respects with the requirements of the Contract Drawings and Specifications for this Project.
(Name of Electrical Subcontractor)

Name _____

Position _____ Date _____
 - i. Failure to provide certification will result in submittals being rejected and returned without review.

- b. Brochures to be submitted as supplementary information shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information. Brochures submitted shall contain only information relevant to the particular equipment or materials to be furnished. The Contractor shall not submit catalogs that describe several different items in addition to those items to be used, unless all irrelevant information is marked out, or unless relevant information is clearly marked. Brochures from each manufacturer shall be identified and submitted separately.
- c. Shop Drawings shall be done in an easily legible scale and shall contain sufficient plans, elevations, sections, and isometrics to clearly describe the equipment or apparatus, and its location. Drawings shall be prepared by an Engineer/Draftsman skilled in this type of work. Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.
- d. Observe the following rules when submitting the Shop Drawings and Brochures.
 - i. Each Shop Drawing shall indicate in the lower right hand corner, and each Brochure shall indicate on the front cover the following: Title of the sheet or brochure, name and location of the building; names of the Architect and Electrical Engineer, Contractor, Subcontractors, Manufacturer, Supplier/Vendor, etc., date of submittal, and the date of correction and revision. Unless the above information is included the submittal will be rejected and returned without being reviewed.
 - 1. Submittal Identification shall include the following:
 - a. A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted.
 - b. Original submittal numbers shall have the following format: "XXX-Y," where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals (for example, A, B, or C being the first, second, and third resubmittals, respectively). Submittal 25B, for example, is the second resubmittal of Submittal 25.

D. POST-SUBMITTAL

- 1. Check all materials and equipment after arrival on the job site and verify compliance with the Contract Documents.

1.3 PROVIDE SUBMITTALS AS REQUESTED FOR EACH OF THE SECTIONS LISTED BELOW:

- A. 26 0519 Conductors and Cables
 - 1. (600V and Below)
 - a. Submit megohmmeter test data for circuits under 600 volts. Megger all circuits of 100 amp and greater rating.
- B. 26 0526 Grounding

Commented [RW1]: Review the below list and update as required for sections being used.

1. Submit the name of test agency to be used for testing specified in this section. Submit results of tests specified in this section. Also include test results in Operation and Maintenance Manuals as specified.
- C. 26 0548 Electrical Seismic Control
1. A single submittal shall be provided for all seismic anchorage and restraints for all Division 26 equipment and systems provided as part of this project. Individual submittals for specific systems will not be accepted.
 2. Submit shop drawings, calculations, and printed data for the following items under provisions of the General Conditions of the Contract:
 - a. Complete engineering calculations and shop drawings for all seismic requirements for all equipment to be restrained as outlined in Section 26 0548 Specification, and as detailed on drawings.
 - b. The professional seal of the engineer who is responsible for the design of the Seismic Restraint System.
 - c. Details for all seismic bracing.
 - d. Details for steel frames, concrete inertia bases, and housekeeping pads. Include dimensions, embed depths, dowelling details, and concrete reinforcing requirements.
 - e. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors, snubbers, cables, and bolt connections.
 - f. Floor plan noting the locations, size, and type of anchorage and restraint to be used.
 - g. Include confirmation that all calculations are based on the design criteria listed in appropriate Section.
 - h. Certificate of Compliance.
 - i. Where equipment is exempt per this specification provide a written certificate of compliance for each of the systems noted with the professional seal of engineer who has reviewed the electrical system.
- D. 26 0553 Electrical Identification
1. Submit manufacturer's data on each type of electrical identification products
 - a. Submit one sample of each component of the electrical identification system as follows: Wire/cable tape marker, Tags, Engraved, plastic laminate labels, Arc-flash hazard labels
- E. 26 2413 Switchgear and Switchboards
1. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2413 submittals received prior to submission of the preliminary protective device study will be REJECTED.
 2. Submit manufacturer's data on switchgear and switchboards.
 3. Submit dimensioned drawings of switchgear and switchboards showing accurately scaled basic sections including, but not necessarily limited to, auxiliary compartments, section components, and combination sections. Show plan view of equipment with dimensioned clearances to proximate equipment. Failure to submit said plan view shall not relieve contractor of responsibility to verify required clearances before release of equipment for fabrication.
- F. 26 2416 Panelboards

1. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2416 submittals received prior to submission of the preliminary protective device study will be REJECTED.
 2. Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, and accessories.
 3. Submit manufacturer data including specifications, installation instructions and general recommendations, for each type of panelboard required.
- G. 26 2713 Service Entrance
1. Submit manufacturer's data on service-entrance equipment and accessories.
 2. Submit dimensioned layouts of service-entrance equipment and spatial relationships to proximate equipment. Failure to submit said layouts shall not relieve contractor of responsibility to verify required clearances before release of equipment to fabrication.
 3. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2713 submittals received prior to submission of the preliminary protective device study will be REJECTED.
- H. 26 2726 Wiring Devices
1. Submit manufacturer's data on electrical wiring devices.
- I. 26 2815 Overcurrent Protective Devices
1. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2815 submittals received prior to submission of the preliminary protective device study will be REJECTED.
 2. Submit manufacturer's data on overcurrent protective devices, including catalog cuts, time-current trip characteristic curves, and mounting requirements.
 3. Submit layout drawings of overcurrent protective devices, with layouts of circuit breakers, including spatial relationships to proximate equipment. Failure to submit said spatial layouts does not relieve contractor of responsibility to verify all required clearances before release of equipment for fabrication.
 4. Submit time-current trip curves (in log-log format) and trip setting parameter/range information (for each trip function) for all solid-state circuit breakers.
 5. Manufacturer shall also provide recommended trip settings with the shop drawing submittal (including ground fault settings) for coordination with downstream overcurrent devices. Manufacturer shall base recommendations on the AIC rating of the electrical equipment.
- J. 26 2816 Motor and Circuit Disconnects
1. Submit manufacturer's data including specifications, installation and general recommendations, for each type of motor and circuit disconnect switch required.
 2. Submit dimensioned drawings of electrical motor and circuit disconnect switches that have rating of 100 amperes and larger.
- K. 26 2913 Motor Starters
1. Submit manufacturer's data on motor starters.

2. Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts.

1.4 OPERATION & MAINTENANCE MANUALS

- A. Provide operating instruction and maintenance data books for all equipment and materials furnished under this Division.
- B. Submit four copies of operating and maintenance data books for review at least four weeks before final review of the project. Assemble all data in a completely indexed volume or volumes and identify the size, model, and features indicated for each item. The binder (sized to the material) shall be a 2" slide lock unit (Wilson-Jones WLJ36544B). The cover shall be engraved with the job title in 1/2" high letters and the name and address of the Contractor in 1/4" high letters. Provide the same information in 1/8" letters on the spine.
- C. Include complete cleaning and servicing data compiled in clearly and easily understandable form. Show serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, etc. Each unit shall have its own individual sheet. (Example: If two items of equipment A and D appear on the same sheet, an individual sheet shall be provided for each unit specified).
- D. Include the following information where applicable.
 1. Identifying name and mark number.
 2. Certified outline Drawings and Shop Drawings.
 3. Parts lists.
 4. Performance curves and data.
 5. Wiring diagrams.
 6. Light fixture schedule with the lamps and ballast data used on the project for all fixtures
 7. Manufacturer's recommended operating and maintenance instructions.
 8. Vendor's name and address for each item.
- E. The engineer shall review the manuals and when approved, will forward the manuals on to the architect. If the manuals are rejected twice, the contractor shall reimburse the engineer the sum of \$1,200.00 for each review afterwards.
- F. Provide Operation and Maintenance Manual information for each section listed below in addition to the general requirements listed above.
 1. 26 0526 Grounding
 - a. Test Results of measured resistance values
 2. 26 0548 Electrical Seismic Control
 - a. Certificate of Compliance from Final Inspection
 3. 26 2913 Motor Starters
 - a. After installation is complete, including water and air balancing, measure voltage (L-L and L-N) and full load current of each phase of each motor. Submit report showing field readings of voltage, amperage, service factor, and thermal heater size installed for each motor.

END OF SECTION 26 0502

SECTION 260507

ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-23 section making reference to electrical connections.

1.2 DESCRIPTION OF WORK:

- A. Extent of electrical connection for equipment includes final electrical connection of all equipment having electrical requirements. Make final connections for all owner furnished equipment. See other applicable portions of specification for building temperature control wiring requirements.
- B. Refer to Division-23 sections for motor starters and controls furnished integrally with equipment; not work of this section.
- C. Refer to Division-23 section for control system wiring; not work of this section.
- D. Refer to sections of other Divisions for specific individual equipment power requirements.

1.3 QUALITY ASSURANCE:

- A. NEC COMPLIANCE: Comply with applicable portions of NEC as to type products used and installation of electrical power connections.
- B. UL LABELS: Provide electrical connection products and materials that have been UL-listed and labeled.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices, terminations, and connections as required. Crimp on or slip-on type splicing materials (insulation displacement type) designed to be used without wire stripping are not acceptable. See Section 26 0532, Conduit Raceways; Section 26 2726 Wiring Devices; and Section 26 0519 Conductors and Cables for additional requirements. Provide final connections for equipment consistent with the following:
 - 1. Permanently installed fixed equipment - flexible seal-tite conduit from branch circuit terminal equipment, or raceway; to equipment, control cabinet, terminal junction box or wiring terminals. Totally enclose all wiring in raceway.
 - 2. Movable and/or portable equipment - wiring device, cord cap, and multi-conductor cord suitable for the equipment and in accordance with NEC requirements (Article 400).
 - 3. Other methods as required by the National Electrical Code and/or as required by special equipment or field conditions.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. Make electrical connections in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams.
- C. Coordinate installation of electrical connections for equipment with equipment installation work.
- D. Verify all electrical loads (voltage, phase, horse power, full load amperes, number and point of connections, minimum circuit ampacity, etc.) for equipment furnished under other Divisions of this specification, **by reviewing respective shop drawings furnished under each division. Meet with each subcontractor furnishing equipment requiring electrical service and review equipment electrical characteristics.** Report any variances from electrical characteristics noted on the electrical drawings to Architect **before proceeding** with rough-work. In summary it is not in the Electrical Engineers scope to review the shop drawings from other trades/divisions.
- E. Obtain and review the equipment shop drawings to determine particular final connection requirements before rough-in begins for each equipment item.
- F. Refer to basic materials and methods Section 26 0553 Electrical Identification, Conductors, for identification of electrical power supply conductor terminations.

END OF SECTION 26 0507

SECTION 26 0519

CONDUCTORS AND CABLES (600V AND BELOW)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to conductors and cables specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of electrical conductor and electrical cable work is indicated by drawings and schedules.
- B. Types of conductors and cables in this section include the following:
 - 1. Copper Conductors (600V)
- C. Applications for conductors and cables required for project include:
 - 1. Power Distribution
 - 2. Feeders
 - 3. Branch Circuits

1.3 RECORDS SUBMITTAL: Refer to Section 26 0502 for requirements.

1.4 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical conductors and cable. Comply with UL standards and provide electrical conductors and cables that have been UL-listed and labeled.
- B. Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of conductors and cable.
- C. Comply with applicable portions of ANSI/ASTM and IEEE standards pertaining to construction of conductors and cable.

1.5 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 COPPER CONDUCTORS (600V):

- A. Provide factory-fabricated conductors of sizes, ratings, materials, and types indicated for each service. Where not indicated provide proper selection to comply with project's installation requirements and NEC standards. Provide conductors in accordance with the following:
 - 1. Service Entrance Conductors – Copper conductor; see drawings for insulation type.
 - 2. Distribution and Panelboard Feeders; and Other Conductors, #2 AWG and Larger – Copper] conductor; see drawings for insulation type.
 - 3. Branch Circuit Conductors and All Conductors #3 AWG and Smaller - Copper conductor, with THHN/THWN insulation. Size all conductors in accordance with

NEC; minimum size to be #12 AWG. Provide solid conductors for #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.

- B. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination.
- C. Provide neutral and ground wire as specified elsewhere in documents.
- D. Provide separate neutral conductor for all single phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install electric conductors and cables as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.
- B. Coordinate installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. Cables may be pulled by direct attachment to conductors or by use of basket weave pulling grip applied over cables. Attachment to pulling device shall be made through approved swivel connection. Nonmetallic jacketed cables of small size may be pulled directly by conductors by forming them into a loop that pull wires can be attached; remove insulation from conductors before forming the loop. Larger sizes of cable may be pulled by using basket weave pulling grip, provided the pulling force does not exceed limits recommended by manufacturer; if pulling more than one cable, bind them together with friction tape before applying the grip. For long pulls requiring heavy pulling force, use pulling eyes attached to conductors.
- D. Do not exceed manufacturer's recommendations for maximum allowable pulling tension, side wall pressure, and minimum allowable bending radius. In all cases, pulling tension applied to the conductors shall be limited to 0.008 lbs. per circular mil of conductor cross-section area.
- E. Pull in cable from the end having the sharpest bend; i.e. bend shall be closest to reel. Keep pulling tension to minimum by liberal use of lubricant, and turning of reel, and slack feeding of cable into duct entrance. Employ not less than one man at reel and one in pullhole during this operation.
- F. For training of cables, minimum bend radius to inner surface of cable shall be 12 times cable diameter.
- G. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50% greater than specified above for training.
- H. Use only wire and cable pulling compound recommended by the specific cable manufacturer, and that is listed by UL.
- I. Seal all cable ends unless splicing is to be done immediately. Conduit bodies shall not contain splices.
- J. Follow manufacturer's instructions for splicing and cable terminations.

3.2 AFTER INSTALLATION TEST FOR CABLE 600 VOLTS AND BELOW:

- A. Prior to energization, test cable and wire for continuity of circuitry, and for short circuits, Megger all circuits of 100 amp and greater rating. Correct malfunctions. Record all test

data and provide written test report.

- B. Subsequent to wire and cable connections, energize circuitry and demonstrate functioning in accordance with requirements.

3.3 IDENTIFICATION OF FEEDERS: Refer to Section 26 0553 for requirements.

END OF SECTION 26 0519



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SECTION 26 0526

GROUNDING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. Provide grounding as specified herein, and as indicated on drawings.
- B. Provide grounding and bonding of all electrical and communication apparatus, machinery, appliances, building components, and items required by the NEC to provide a permanent, continuous, low impedance, grounding system.
- C. Unless otherwise indicated, ground the complete electrical installation including the system neutral, metallic conduits and raceways, boxes, fittings, devices, cabinets, and equipment in accordance with all code requirements.
- D. Ground each separately derived system, as described in NEC Section 250-30, unless otherwise indicated.
- E. Types of grounding in this section include the following:
 - 1. Grounding Rods
 - 2. Separately Derived Systems
 - 3. Service Equipment
 - 4. Enclosures
 - 5. Systems
 - 6. Equipment
 - 7. Other items indicated on drawings
- F. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to electrical grounding and ground fault protection systems. Comply with applicable ANSI and IEEE requirements. Provide products that have been UL listed and labeled.
- B. Resistance from the service entrance ground bus, through the grounding electrode to earth, shall not exceed 5 ohms.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. GENERAL: Except as otherwise indicated, provide each electrical grounding system as specified herein, and as shown on drawings, including but not necessarily limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, and other items and accessories needed for complete

installation. Where materials or components are not otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.

- B. ELECTRICAL GROUNDING CONDUCTORS: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC. Provide with green insulation.
- C. GROUND RODS: Steel with copper welded exterior, 3/4" dia. x 10' long. Weaver or Cadweld.
- D. GROUND WELL BOXES FOR GROUND RODS: Precast concrete box 9-1/2" W. x 16" L. X 18" D. with light duty concrete cover for non-traffic areas or rated steel plate for traffic areas. Provide covers with lifting holes. Engrave cover with "GROUND ROD".
- E. INSULATED GROUNDING BUSHINGS: Plated malleable iron body with 150 degree Centigrade molded plastic insulating throat, lay-in grounding lug with hardened stainless steel fasteners, OZ-Gedney BLG, or Thomas & Betts #TIGB series.
- F. CONNECTIONS TO PIPE: For cable to pipe, OZ-Gedney G-100B series or Thomas & Betts #390X series, or Burndy type GAR.
- G. CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS, OR SPLICES: For splicing and/or connecting conductors, use exothermic welds or high pressure compression type connectors. Provide exothermic weld kits manufactured by Cadweld or Thermoweld. If high compression type connectors are used for cable-to-cable, or cable-to-steel, or cable-to-ground rod connections, provide Thomas & Betts #53000 series, or Burndy Hyground series.
- H. BONDING JUMPERS: OZ-Gedney Type BJ, or Thomas & Betts #3840 series, or Burndy type GG and type B braid.

PART 3 - EXECUTION

3.1 INSTALLATION OF GROUNDING SYSTEMS:

- A. Install electrical grounding systems in accordance with manufacturer's written instructions and with recognized industry practices to ensure grounding devices comply with requirements.
- B. Install clamp-on connectors only on thoroughly cleaned and metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- C. Provide grounding for the entire raceway, enclosure, equipment and device system in accordance with NEC. All raceways shall include copper grounding conductor sized in accordance with NEC.
- D. Provide service entrance grounding by means of ground rods (quantity of two, driven exterior to building). Size electrode in accordance with NEC, but in no case, smaller than No. 4 AWG bare copper. Support electrode so as to be below finished grade near the bottom of the trench, and approximately three inches from the bottom or sides of the concrete. Locate a point of connection for inspection.

3.2 GROUNDING ELECTRODES:

- A. Separately Derived Electrical System Grounding Electrode: Ground each separately derived system per requirements in NEC Section 250-26 unless indicated otherwise.
- B. GROUNDING ELECTRODE CONDUCTOR: Provide grounding electrode conductor sized per NEC table 250-94 or as indicated.
- C. POWER SYSTEM GROUNDING: Connect the following items using NEC sized copper grounding conductors to lugs on the Service Ground Bus.
 - 1. Ground for separately derived systems.

- D. Run main grounding conductors exposed or in metallic conduit if protection or concealment is required.
- E. EQUIPMENT BONDING/GROUNDING: Provide a NEC sized conductor, whether indicated or not on the drawings, in raceways as follows:
 - 1. Non-metallic conduits and ducts.
 - 2. Distribution feeders.
 - 3. Motor and equipment branch circuits.
 - 4. Device and lighting branch circuits.
 - 5. Provide grounding bushings and bonding jumpers for all conduit terminating in reducing washers, concentric, eccentric or oversized knockouts at panelboards, cabinets and gutters.
- F. Provide bonding jumpers across expansion and deflection couplings in conduit runs, across pipe connections at water meters, and across dielectric couplings in metallic cold water piping system.
- G. Provide bonding wire in all flexible conduit.

3.3 TESTING:

- A. Obtain and record ground resistance measurements both from service entrance ground bus to the ground electrode and from the ground electrode to earth. Install additional bonding and grounding electrodes as required to comply with resistance limits specified under this Section.
- B. Include typewritten records of measured resistance values in the Operation and Maintenance Manual.
- C. Use independent testing agency for all testing.
- D. Use test equipment expressly designed for the purpose intended. Submit name of testing agency for review and approval, in writing, to the Engineer prior to the performance of any testing.

END OF SECTION 26 0526

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SECTION 26 0529

SUPPORTING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification section, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to supports, anchors, sleeves, and seals, specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of supports, anchors, and sleeves is indicated by drawings and schedules and/or specified in other Division-26 sections. See Section 260532, Raceways, for additional requirements.
- B. Work of this section includes supports, anchors, sleeves and seals required for a complete raceway support system, including but not limited to: clevis hangers, riser clamps, C-clamps, beam clamps, one and two hole conduit straps, offset conduit clamps, expansion anchors, toggle bolts, threaded rods, U-channel strut systems, threaded rods and all associated accessories.

1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical supporting devices. Comply with applicable requirements of ANSI/NEMA Std. Pub No. FB 1, "Fittings and Supports for Conduit and Cable Assemblies". Provide electrical components that are UL-listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES:

- A. GENERAL:
 - 1. Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. See drawings for additional requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES:

- A. Install hangers, anchors, sleeves, and seals as required, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements. Comply with requirements of NECA, NEC and ANSI/NEMA for installation of supporting devices.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Install hangers, supports, clamps and attachments to support piping properly from building structures. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. For pre-and post tensioned construction, use pre-set inserts for support of all electrical work. Do not use toggle bolts, moly bolts,

wood plugs or screws in sheetrock or plaster as support for any equipment or raceway.

D. RACEWAYS:

1. Support raceways that are rigidly attached to structure at intervals not to exceed 8 feet on center, minimum of two straps per 10 foot length of raceway, and within 12" of each junction box, coupling, outlet or fitting. Support raceway at each 90° degree bend. Support raceway (as it is installed) in accordance with the following:

<u>NUMBER OF RUNS</u>	<u>3/4" TO 1-1/4" Ø</u>	<u>1-1/2" & LARGER Ø</u>
1	Full straps, clamps or hangers.	Hanger
2	Full straps, clamps or hangers.	Mounting Channel
3 or more	Mounting Channel	Mounting Channel

2. Support suspended raceways on trapeze hanger systems; or individually by means of threaded rod and straps, clamps, or hangers suitable for the application. Do not use independent support wires as a portion of any raceway support system; do not support raceway from ceiling support wires.

E. FLOOR MOUNTED EQUIPMENT:

1. Provide rigid attachment of all floor mounted equipment to the floor slab or structural system. Provide 5/8" bolts or expansion anchors at each 90 degree corner and at intervals not to exceed 48" on center along entire perimeter of the equipment. Provide rigid attachment for all floor mounted switchboards, panelboards, power and control equipment, motor control centers, dimmer cabinets, transformers (provide neoprene vibrations isolators at anchor points), oil switches, battery packs and racks, and similar equipment furnished under Division 26, 27 and 28.

END OF SECTION 26 0529

SECTION 26 0532

CONDUIT RACEWAY

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to electrical raceways and specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of raceways is indicated by drawings and schedules.
- B. Types of raceways in this section include the following:
 - 1. Electrical Metallic Tubing
 - 2. Flexible Metal Conduit
 - 3. Intermediate Metal Conduit
 - 4. Liquid-tight Flexible Metal Conduit
 - 5. Rigid Metal Conduit
 - 6. Rigid Non-metallic Conduit

1.3 QUALITY ASSURANCE:

- A. MANUFACTURERS: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.
- B. STANDARDS: Comply with applicable portions of NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components that have been UL-listed and labeled. Comply with NEC requirements as applicable to construction and installation of raceway systems.
- C. SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 METAL CONDUIT AND TUBING:

- A. GENERAL:
 - 1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".
- B. RIGID METAL CONDUIT (RMC): FS WW-C-0581 and ANSI C80.1.
- C. INTERMEDIATE STEEL CONDUIT (IMC): FS WW-C-581.
- D. PVC EXTERNALLY COATED RIGID STEEL CONDUIT: ANSI C80.1 and NEMA Std. Pub. No. RN 1.
- E. ALUMINUM CONDUIT: Not acceptable.
- F. MC CABLE: Not acceptable.

- G. RIGID AND INTERMEDIATE STEEL CONDUIT FITTINGS:
 - 1. Provide fully threaded malleable steel couplings; raintight and concrete tight where required by application. Provide double locknuts and metal bushings at all conduit terminations. Install OZ Type B bushings on conduits 1-1/4" and larger.
- H. ELECTRICAL METALLIC TUBING (EMT): FS WW-C-563 and ANSI C80.3.
- I. EMT FITTINGS:
 - 1. Provide insulated throat nylon bushings with non-indenter type malleable steel fittings at all conduit terminations. Install OZ Type B bushings on conduits 1" larger. Cast or indenter type fittings are not acceptable.
- J. FLEXIBLE METAL CONDUIT: FS WW-C-566, of the following type;
 - 1. Zinc-coated steel.
- K. FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 1, and Style A.
- L. LIQUID TIGHT FLEXIBLE METAL CONDUIT:
 - 1. Provide liquid-tight, flexible metal conduit; constructed of single strip, flexible continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coated with liquid-tight jacket of flexible polyvinyl chloride (PVC).
- M. LIQUID-TIGHT FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 3, Style G.
- N. EXPANSION FITTINGS: OZ Type AX, or equivalent to suit application.

2.2 NON-METALLIC CONDUIT AND DUCTS:

- A. GENERAL:
 - 1. Provide non-metallic conduit, ducts and fittings of types, sizes and weights as indicated; with minimum trade size of 3/4".
- B. UNDERGROUND PVC PLASTIC UTILITIES DUCT:
 - 1. Minimum requirements shall be schedule 40 for encased burial in concrete and for Type II for direct burial.
- C. PVC AND ABS PLASTIC UTILITIES DUCT FITTINGS:
- D. ANSI/NEMA TC 9, match to duct type and material.
- E. HDPE CONDUIT: Not acceptable.

2.3 CONDUIT; TUBING; AND DUCT ACCESSORIES:

- A. Provide conduit, tubing and duct accessories of types and sizes, and materials, complying with manufacturer's published product information, that mate and match conduit and tubing. Provide manufactured spacers in all duct bank runs.

2.4 SEALING BUSHINGS:

- A. Provide OZ Type FSK, WSK, or CSMI as required by application. Provide OZ type CSB internal sealing bushings.

2.5 CABLE SUPPORTS:

- A. Provide OZ cable supports for vertical risers, type as required by application.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS:

- A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and in accordance with the following:
 - 1. SERVICE ENTRANCE CONDUCTORS, AND CONDUCTORS OVER 600 VOLTS:
 - a. Install in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct, individually encased in concrete. See duct banks.
 - 2. FEEDERS UNDER 600 VOLTS:
 - a. Install feeders to panels and motor control centers and individual equipment feeders rated 100 amps and greater, in rigid metal conduit (RMC), or intermediate metal conduit (IMC), or Electrical Metallic Tubing (EMT); except where buried below grade, install in non-metallic conduit or duct. Encase feeders 1-1/4" and larger, individually in concrete where installed below grade. See duct banks.
 - 3. BRANCH CIRCUITS, SIGNAL AND CONTROL CIRCUITS, AND INDIVIDUAL EQUIPMENT CIRCUITS RATED LESS THAN 100 AMPS:
 - a. Install in electric metallic tubing (EMT). Below concrete slab-on-grade or in earth fill, install in non-metallic plastic duct. In areas exposed to weather, moisture, or physical damage, install in RMC or IMC.
- B. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.
- C. Install raceway in accordance with the following:
 - 1. Provide a minimum of 12" clearance measured from outside of insulation from flues, steam and hot water piping, etc. Avoid installing raceways in immediate vicinity of boilers and similar heat emitting equipment. Conceal raceways in finished walls, ceilings and floor (other than slab-on-grade), except in mechanical, electrical and/or communication rooms, conceal all conduit and connections to motors, equipment, and surface mounted cabinets unless exposed work is indicated on the drawings. Run concealed conduits in as direct a line as possible with gradual bends. Where conduit is exposed in mechanical spaces, etc., install parallel with or at right angles to building or room structural lines. Do not install lighting raceway until piping and duct work locations have been determined in order to avoid fixtures being obstructed by overhead equipment.
 - 2. Where cutting raceway is necessary, remove all inside and outside burrs; make cuts smooth and square with raceway. Paint all field threads (or portions of raceway where corrosion protection has been damaged) with primer and enamel finish coat to match adjacent raceway surface.
 - 3. Provide a minimum of 1 1/2" from nearest surface of the roof decking to raceway.
 - 4. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination.
 - 5. Provide neutral and ground wire as specified elsewhere in documents.

6. Provide separate neutral conductor for all single phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.
- D. Comply with NEC for requirements for installation of pull boxes in long runs.
- E. Cap open ends of conduits and protect other raceways as required against accumulation of dirt and debris. Pull a mandrel and swab through all conduit before installing conductors. Install a 200 lb. nylon pull cord in each empty conduit run.
- F. Replace all crushed, wrinkled or deformed raceway before installing conductors.
- G. Do not use flame type devices as a heat application to bend PVC conduit. Use a heating device that supplies uniform heat over the entire area without scorching the conduit.
- H. Provide rigid metal conduit (RMC) for all bends greater than 22 degrees in buried conduit. Provide protective coating for RMC bend as specified herein.
- I. Where raceways penetrate building, area ways, manholes or vault walls and floors below grade, install rigid metal conduit (RMC) for a minimum distance of 10 feet on the exterior side of the floor or wall measured from interior face. Provide OZ, Type FSK, WSK or CSMI sealing bushings (with external membrane clamps as applicable) for all conduit penetrations entering walls or slabs below grade. Provide segmented type CSB internal sealing bushings in all raceways penetrating building walls and slabs below grade, and in all above grade raceway penetrations susceptible to moisture migration into building through raceway.
- J. Install liquid-tight flexible conduit for connection of motors, transformers, and other electrical equipment where subject to movement and vibration.
- K. Provide OZ expansion fittings on all conduits crossing building expansion joints, both in slab and suspended.
- L. Provide OZ cable supports in all vertical risers in accordance with NEC 300-19; type as required by application.
- M. Complete installation of electrical raceways before starting installation of cables/conductors within raceways.
- N. Raceway installation below grade:
 1. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.
 2. Burial depths must comply with NEC Section 300-5 but in no case be less than 24", unless noted otherwise on drawings.
- O. Electrical Identification: Refer to Section 260553 for requirements.
- P. SPARE PARTS: Refer to Section 26 0502 for requirements.

END OF SECTION 26 0532

SECTION 26 0533

ELECTRICAL BOXES AND FITTINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to electrical wiring boxes and fittings specified herein. See Section 260532, Raceways, for additional requirements.

1.2 DESCRIPTION OF WORK:

- A. The extent of electrical box and electrical fitting work is indicated by drawings and schedules.
- B. Types of electrical boxes and fittings in this section include the following:
 - 1. Outlet Boxes
 - 2. Junction Boxes
 - 3. Pull Boxes
 - 4. Conduit Bodies
 - 5. Bushings
 - 6. Locknuts
 - 7. Knockout Closures
 - 8. Miscellaneous Boxes and Fittings

1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings. Comply with ANSI C 134,1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, device boxes, covers and box supports. Provide electrical boxes and fittings that have been UL-listed and labeled.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS:

- A. INTERIOR OUTLET BOXES:
 - 1. Provide one piece, galvanized flat rolled sheet steel interior outlet wiring boxes with accessory rings, of types, shapes and sizes, including box depths, to suit each respective location and installation, construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box and covers and wiring devices; minimum size 4"x4"x2-1/8".
 - 2. Provide an 'FS' box, with no knockouts when surface mounted in a finished, non-utility space. Surface mounting is only acceptable when approved by the Architect.
- B. INTERIOR OUTLET BOX ACCESSORIES:
 - 1. Provide outlet box accessories as required for each installation, including mounting brackets, hangers, extension rings, fixture studs, cable clamps and metal straps

for supporting outlet boxes, that are compatible with outlet boxes being used and fulfilling requirements of individual wiring applications.

C. WEATHERPROOF OUTLET BOXES:

1. Provide corrosion-resistant cast-metal weatherproof outlet wiring boxes, of types, shapes and sizes (including depth) required, with threaded conduit ends, cast-metal face plates with spring-hinged waterproof caps suitably configured for each application, with face plate gaskets and corrosion-resistant fasteners.

D. JUNCTION AND PULL BOXES:

1. Provide code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

E. CONDUIT BODIES:

1. Provide galvanized cast-metal conduit bodies, of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

F. BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS:

1. Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable steel conduit bushings and offset connectors, of types and sizes to suit respective uses and installation.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. GENERAL:

1. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
2. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.
3. Provide coverplates for all boxes. See Section 262726, Wiring Devices.
4. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.
5. Provide knockout closures to cap unused knockout holes where blanks have been removed.
6. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Do not install boxes above ducts or behind equipment. Install recessed boxes with face of box or ring flush with adjacent surface. Seal between switch, receptacle and other outlet box openings and adjacent surfaces with plaster, grout, or similar suitable material.
7. Fasten boxes rigidly to substrates or structural surfaces, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them. Set boxes on opposite sides of fire resistant walls with minimum of 24" separation.
8. Provide a minimum of 1 ½" from the nearest surface of the roof decking to the installed boxes.
9. Provide electrical connections for installed boxes.

END OF SECTION 26 0533

SECTION 26 0548

ELECTRICAL SEISMIC CONTROL

PART 1 – GENERAL

1.1 WORK INCLUDED:

- A. Anchorage and seismic restraint systems for all Division 26 isolated and non-isolated equipment, cable tray, and conduit systems.
- B. Anchorage and seismic restrain systems for electrical components shall include but not be limited to the following:
 - 1. Pad Mounted Equipment
 - 2. Conduit
 - 3. Cable Tray
 - 4. Bus Duct
 - 5. Light Fixtures

1.2 RELATED WORK:

- A. Requirements: Provide Electrical Seismic Control in accordance with the Contract Documents.
- B. Section 260500 – Electrical General Provisions

1.3 REFERENCES:

- A. International Building Code, Current Edition in use by Jurisdictional Authority.
- B. NFPA Bulletin 90A, Current Edition.
- C. UL Standard 181.
- D. ASCE 7-10

1.4 SYSTEM DESCRIPTION

- A. The Division 26 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:
 - 1. Short period design spectral response acceleration coefficient $SDS=0.70$.
 - 2. One second period design spectral response acceleration coefficient $SD1=0.28$.
 - 3. Site Class B.
 - 4. Seismic Design Category D.
 - 5. Importance Factor (I_p) = 1.0
- B. Seismic Restraint Exceptions
 - 1. The following components are exempt from the requirements of this section

1.5 QUALITY ASSURANCE:

- A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for electrical equipment. Shop drawings submitted for earthquake bracing and anchors shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 26

equipment and systems shall be provided by a single firm.

- B. The above qualified seismic engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the electrical equipment that have been submitted, reviewed and accepted by the Architect/Engineer for this project.
- C. Seismic Engineer or the Engineer's Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer's design. A certificate of compliance bearing the Seismic Engineer's signed Professional Engineer's seal shall be submitted and shall be included in each copy of the Operation and Maintenance Manuals.
- D. The Division 26 Contractor shall require all equipment suppliers furnish equipment that meets the seismic code, with bases/skids/curb designed to receive seismic bracing and/or anchorage. All isolated and non-isolated electrical equipment bracing to be used in the project shall be designed from the Equipment Shop Drawings and certified correct by the equipment manufacturer for seismic description listed in Paragraph 1.4 above, with direct anchorage capability.

1.6 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS:

2.1 RESTRAINT EQUIPMENT AND SYSTEMS:

- A. Acceptable Manufacturers and Suppliers for Non-Isolated Systems:
 - 1. Mason Industries, Inc.
 - 2. Korfund
 - 3. Amber/Booth Company
 - 4. Vibration Mountings and Control Company
 - 5. Kinetics
 - 6. International Seismic Application Technology
 - 7. Tolco
- B. Manufacture and design of restraints and anchors for isolated equipment shall be by the manufacturer of the vibration isolators furnished for the equipment.

2.2 SNUBBERS:

- A. Snubbers shall be all-directional and consist of interlocking steel members restrained by replaceable shock absorbent elastomeric materials a minimum of 3/4 inch thick.
- B. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.
- C. Snubbers shall be Mason Industries Z -1011 or accepted equivalent.

PART 3 – EXECUTION

3.1 DESIGN AND INSTALLATION:

- A. General:
 - 1. All electrical components shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials, and equipment for protection against seismic disturbances as specified herein. The following electrical components are exempt from seismic restraint requirements.

- a. Electrical components in Seismic Design Category A or B (see section 1.4)
 - b. Electrical components in Seismic Design Category C provided that the component importance factor, I_p , is equal to 1.0 (see section 1.4).
 - c. Electrical components in Seismic Design Categories D, E, or F where all of the following apply:
 - i. The component importance factor, I_p , is equal to 1.0;
 - ii. The component is positively attached to the structure;
 - iii. Flexible connections are provided between the component and associated ductwork, piping, and conduit; and either
 1. The component weighs 400 lb (1,780 N) or less and has a center of mass located 4 ft (1.22 m) or less above the adjacent floor level; or
 2. The component weighs 20 lb (89 N) or less or, in the case of a distributed system, 5 lb/ft (73 N/m) or less.
2. Powder-actuated fasteners (shot pins) shall not be used for component anchorage in tension applications in Seismic Design Category D, E, or F.
 3. Attachments and supports for electrical equipment shall meet the following provisions:
 - a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural code such as, when constructed of steel, AISC, Manual of Steel Construction (Ref. 9.8-1 or 9.8-2).
 - b. Friction clips shall not be used for anchorage attachment.
 - c. Expansion anchors shall not be used for electrical equipment rated over 10 hp (7.45 kW). Exception: Undercut expansion anchors.
 - d. Drilled and grouted-in-place anchors for tensile load applications shall use either expansive cement or expansive epoxy grout.
 - e. Supports shall be specifically evaluated if weak-axis bending of light-gauge support steel is relied on for the seismic load path.
 - f. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as $2F_p$. The intent is to prevent excessive movement and to avoid fracture of support springs and any non- ductile components of the isolators.
 - g. Seismic supports shall be constructed so that support engagement is maintained.

B. Pad Mounted Equipment

1. Spring Isolated Equipment:

- a. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.
2. Non-Isolated Equipment:
 - a. The section 260548 (Electrical Seismic Control) Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment i.e. switchboards, transformers, generators, etc. to be restrained. This Contractor shall be responsible for certifying that this equipment is mounted and braced such that it adheres to the system description criteria in part 1.4 of this specification section.
- C. Conduit, Conduit Racks/Trapeze Assemblies, Cable Tray and Bus Duct:
 1. Seismic braces for be omitted when the distance from the supporting structure to the raceway support point is 12" or less. Where rod hangers are used, they shall be equipped with swivels to prevent inelastic bending in the rod.
 2. Seismic braces may be omitted where the total weight of the assembly is less than 10 lb/ft.
 3. Seismic braces for individual conduit may be omitted for conduit less than 2.5 inch trade size.
 4. A rigid conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
 5. Unbraced conduit attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.
 6. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the structure.
 7. Provide large enough pipe sleeves through wall or floors to allow for anticipated differential movements.
 8. For spaces, where the Importance Factor (I_p) is equal to 1.5, all electrical components that are attached to structures that could displace relative to one another and for isolated structures where components cross the isolation interface, the components shall be designed to accommodate the seismic relative displacements.

END OF SECTION 26 0548

SECTION 26 0553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. "Basic Electrical Requirements".
 - 2. "Basic Electrical Materials and Methods".

1.2 SUMMARY

- A. This section includes identification of electrical materials, equipment and installations. It includes requirements for electrical identification components including but not limited to the following:
 - 1. Buried electrical line warnings.
 - 2. Identification labels for raceways, cables and conductors.
 - 3. Operational instruction signs.
 - 4. Warning and caution signs.
 - 5. Equipment labels and signs.
 - 6. Arc-flash hazard labels
- B. Related Sections: The following sections contain requirements that relate to this section:
- C. Division 9 Section "Painting" for related identification requirements.
- D. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

1.3 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code"

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. American Labelmark Co.
 - 2. Calpico, Inc.
 - 3. Cole-Flex Corp.
 - 4. Emed Co., Inc.
 - 5. George-Ingraham Corp.
 - 6. Ideal Industries, Inc.
 - 7. Kraftbilt

8. LEM Products, Inc.
9. Markal Corp
10. National Band and Tag Co.
11. Panduit Corp.
12. Radar Engineers Div., EPIC Corp.
13. Seton Name Plate Co.
14. Standard Signs, Inc.
15. W.H Brady, Co.

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Conduit Systems for raceway identification:
 1. Factory-painted conduit and/or factory-painted couplings and fittings
- B. Colored paint for raceway identification:
 1. Use [Kwal Paint](#) colors as specified in Part 3 – Execution.
- C. Color Adhesive Marking Tape for Raceways, Wires and Cables:
 1. Self-adhesive vinyl tape not less than 3 mills thick by 1” to 2” in width.
- D. Underground Line Detectable Marking Tape:
 1. Permanent, bright colored, continuous-printed, acid- and alkali-resistant plastic tape specifically compounded for direct-burial service. Not less than 6” wide by 4 mills thick.
 2. With metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep.
 3. Printed legend indicative of general type of underground line below.
- E. Wire/Cable Designation Tape Markers:
 1. Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letters.
- F. Brass or Aluminum Tags:
 1. Metal tags with stamped legend, punched for fastener.
 2. Dimensions: 2” X 2” 19 gage.
- G. Engraved, Plastic Laminated Labels, Signs and Instruction Plates:
 1. Engraving stock plastic laminate, 1/16” minimum thickness for signs up to 20 sq. in. or 8” in length; 1/8 “ thick for larger sizes. Engraved legend in 1/4” high white letters on black face and punched for mechanical fasteners.
- H. Arc-flash Hazard Labels:
 1. ANSI Z535.4 Safety Label.
 2. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.
 3. Dimensions: 5” x 3.5”
 4. Information contained: Arc-flash boundary; Voltage; Flash Hazard Category; Incident Energy (arc rating); checkboxes for the required Personal Protective Equipment (PPE) and the date that the calculations were performed.
- I. Equipment Labels:
 1. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.

2. Dimensions: minimum 5" x 2"
3. Conductor-Identification-Means Labels:
 - a. Information contained: the method utilized for identifying ungrounded conductors within switchboards, distribution panels and branch circuit panels.
4. Available-Fault-Current Labels:
 - a. Information contained: maximum available fault current at the respective piece of equipment, and date of calculation of fault current.
5. Source-of-Supply Labels:
 - a. Information contained: indicate the device or equipment where the power supply originates.
- J. Baked Enamel Warning and Caution Signs for Interior Use:
 1. Preprinted aluminum signs, punched for fasteners, with colors legend and size appropriate to location.
- K. Fasteners for Plastic-Laminated and Metal Signs:
 1. Self-tapping stainless steel screws or # 10/32 stainless steel machine screws with nuts, flat and lock washers.
- L. Cable Ties:
 1. Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18" minimum width, 50-lb. Minimum tensile strength, and suitable for a temperature range from minus 40° F. to 185° F. Provide ties for specified colors when used for color coding.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics:
 1. Coordinate names, abbreviations, colors and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- C. Sequence of Work:
 1. Where identification is to be applied to surfaces that require a finish, install identification after completion of finish work.
- D. Conduit Identification:
 1. Identify Raceways of Certain Systems with Color Coding. Acceptable means of color identification are as follows:
 - a. Colored adhesive marking tape.
 - b. Field-painted colored bands.
 - c. Factory-painted conduit.
 - d. Color exposed or accessible raceways of the following systems for identification. Make each color band 2 inches wide, completely encircling conduit. Apply bands at changes in direction, at penetrations of walls and floors, and at 20-foot maximum intervals in straight runs. Apply the following colors:
 - i. Fire Alarm System: Red

- ii. Sound/IC: Blue
 - iii. Telephone: Yellow
 - iv. Data: Green
 - v. MATV: Black
 - vi. Security: Orange
2. Identify Junction, Pull and Connection Boxes.
- a. Code-required caution sign for boxes shall be pressured-sensitive, self-adhesive label indication system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers on outside of cover with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or plasticized card stock tags at concealed boxes.
3. Label and paint the covers of the systems junction boxes as follows:

<u>SYSTEM</u>	<u>COLOR (ALL COLORS ARE KWAL PAINT)</u>	
Fire Alarm	Red Alert	AC118R
Sound/IC	Neon Blue	7076A
Telephone	Competition Yellow	7225A
Data	Java Green	AC098N
MATV	Flat Black	
Security	Fiesta Orange	AC107Y

E. Underground Electrical Line Identification.

- 1. During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground line detectable marking tape, located directly above line at 6 to 8 inches below finished grade. Where multiple lines are installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
- 2. Install detectable marking tape for all underground wiring, both direct-buried and in raceway.
- 3. Provide red marker dye applied to concrete encased ductbank.

F. Conductor Color Coding.

- 1. Provide color coding for secondary service, feeder and branch circuit conductors throughout the project secondary electrical system as follows:

<u>CONDUCTOR</u>	<u>208Y / 120V System</u>	<u>480Y / 277V System</u>
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Shared/Single Neutral	White	Gray
Neutral A (dedicated)	White w/Black Stripe	Gray w/Black Stripe
Neutral B (dedicated)	White w/Red Stripe	Gray w/Orange Stipe
Neutral C (dedicated)	White w/Blue Stripe	Gray w/Yellow Stipe
Equipment Ground	Green	Green

Isolated Ground	Green w/Yellow Strip	Green w/Yellow Stripe
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2. Switch legs, travelers and other wiring for branch circuits shall be of colors other than those listed above.
 3. Use conductors with color factory applied the entire length of the conductors except as follows:
 - a. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - b. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
 - c. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
- G. Power Circuit Identification.
1. Securely fasten identifying metal tags or aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb monofilament line or one-piece self-locking nylon cable ties.
 2. Tag or label conductors as follows:
 - a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
 - b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/ signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- H. Apply warning, caution and instruction signs and stencils as follows:
1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs

- with metal backing for outdoor items. Warning and caution signs shall be furnished and installed on, but not be limited to the following equipment and locations:
- a. Entrances to rooms and other guarded locations that contain exposed live parts 600 volts or less; signs shall forbid unqualified personnel to enter.
 - b. Switch and Overcurrent device enclosures with splices, taps and feed-through conductors. Provide warning label on the enclosures that identifies the nearest disconnecting means for any feed-through conductors.
 - c. Entrances to buildings, vaults, rooms or enclosures containing exposed live parts or exposed conductors operating at over 600 volts: DANGER-HIGH VOLTAGE-KEEP OUT.
 - d. Metal-enclosed switchgear, unit substations, transformers, enclosures, pull boxes, connection boxes and similar equipment operating at over 600 volts shall have appropriate caution signs and warning labels.
 - e. Indoor and Outdoor substations operating over 600 volts. Provide warning signs, instructional signs and single-line diagrams in accordance with NEC 225.70.
- I. Emergency Operating Signs: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
 - J. Install equipment/system circuit/device identification as follows:
 1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1/4"-high lettering on 1-inch-high label (1 1/2-inch-high where two lines are required) white lettering in black field. White lettering in red field for Emergency Power Systems. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
 - a. Each service disconnect, to identify it as a service disconnect.
 - b. Panelboards (exterior and interior), electrical cabinets, and enclosures. For subpanels, identify feeder circuit served from.
 - c. Switches in fusible panelboards shall be labeled. Main switches shall be identified.
 - d. Electrical switchgear and switchboards.
 - e. Motor starters, including circuit origination, HP, heater size, FLA, and mechanical equipment designation.
 - f. Disconnect switches.
 - g. Control devices.
 - h. Transformers.
 - i. Variable frequency drives.
 - K. Post Conductor-Identification-Means labels at locations of switchboards, distribution panels and branch circuit panels. The labels shall identify the color-coding used on ungrounded conductors for each voltage system used on the premises.
 - L. Apply Available-Fault-Current labels at the service entrance equipment.
 - M. Apply Source-of-Supply labels on the exterior covers of equipment (except in single- or two-family dwellings) as follows:
 1. Each switchboard supplied by a feeder.

2. Each branch circuit panelboard supplied by a feeder.
 3. Each disconnect switch serving elevators, escalators, moving walks, chairlifts, platform lifts and dumbwaiters.
 4. Each dry type transformer (or primary-side disconnect switch at transformer). If the primary-side disconnect is remote from the transformer, both the remote disconnect and the transformer shall be labeled, and the transformer label shall also indicate the location of the disconnect.
 5. Each feeder disconnect, branch circuit disconnect, panelboard or switchboard in a remote building or structure.
 6. Each on-site emergency power source, with sign placed at service entrance equipment to comply with NEC 700.
- N. The label shall identify the device or equipment where the power supply originates, and the system voltage and phase. For example: Feeder Power Supply for Panel "XX" Originates at Panel "XX" (or Switchboard "XX", Transformer "XX", Switch "XX", etc.); 120/208 volts, 3-phase (or 120/240, 277/480, etc.).
- O. Install Arc-flash hazard labels on the following equipment:
1. Each piece of service entrance equipment.
 2. Each power distribution switchboard or panel.
 3. Each individually mounted circuit breaker.
 4. Each branch circuit panelboard.
 5. Each motor control center.
 6. Each individually mounted motor starter.
 7. Each meter socket enclosure.
- P. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.
- Q. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- R. Engrave all receptacle plates other than those serving 120 volt, single phase devices. State voltage and amperage characteristics: Example; "208V 30A".
- S. Mark each device box (for each type of wiring device) with a permanent ink felt tip marker, indicating the circuit that the device is connected to: Example; "CKT A-1"

END OF SECTION 26 0553

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SECTION 26 2413

SWITCHGEAR AND SWITCHBOARDS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and methods sections apply to work of this section except as otherwise indicated. See Section 262713 Service Entrance, for metering requirements. See Section 264313 for SPD requirements.

1.2 DESCRIPTION OF WORK:

- A. Extent of switchgear and switchboards is indicated by drawings and schedules.
- B. Types of switchgear and switchboards in this section include the following:
 - 1. AC Dead Front Switchboards (600V)

1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical switchgear and switchboards. Provide switchgear and switchboards that have been UL listed and labeled.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

- A. MAINTENANCE STOCK FUSES: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products of one of the following (for each type of switchgear and switchboard):
- B. AC DEAD FRONT SWITCHBOARDS (600V):
 - 1. Cutler-Hammer Products, Eaton Corp.
 - 2. GE/ABB
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D Co.

2.2 EQUIPMENT SECTIONS AND COMPONENTS:

- A. GENERAL: Except as otherwise indicated, provide switchgear and switchboards of types, sizes, characteristics, and ratings indicated, that comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation. See drawings and Section 262815. Series rated systems are not accepted.
- B. Overcurrent Protection Devices, for main and branch devices. Provide switchgear, switchboards, and overcurrent devices of one manufacturer.

2.3 AC DEAD-FRONT SWITCHBOARDS (600V):

- A. Provide factory assembled, dead front, metal enclosed, floor standing, self supporting,

group mounted, secondary power switch boards, of sizes, electrical ratings and characteristics indicated consisting of panel (vertical) units, and containing circuit breaker and fusible switch assemblies of quantities, ratings and types indicated. Provide copper main bus and connections to switching devices of sufficient capacity to limit rated continuous current operating temperature rise to UL standard; with main bus and tap connections silver-surfaced or tin-plated and tightly bolted for maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Prime and paint switchboard with manufacturer's standard finish and color. Equip units with built-in lifting eyes and yokes; provide individual panel (vertical) units, suitable for bolting together at project site, and constructed for the following environment:

1. Installation: Indoors, NEMA Type 1.
- B. Limit height of upper most overcurrent device handle to 6'-2" to accommodate 4" curb.

PART 3 - EXECUTION

3.1 INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS:

- A. Install switchgear and switchboards where shown, in accordance with manufacturer's written instructions with recognized industry practices to ensure that switchgear and switchboards comply with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".
- B. Install all switchgear and switchboards on 4" high concrete curb. Install concrete wiring trench under switchgear and switchboards; 18" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench. Secure equipment to pad/trench. Refer to section 26 0548 Electrical Seismic Control.
- C. Arrange conductors within switchgear and switchboards in neat fashion, and secure with suitable ties.
- D. Tighten fuses, if any, in each switchgear and switchboard.
- E. Provide and install spare fuse cabinet in main electrical room.
- F. Electrical Identification: Refer to Section 260553 for requirements.

3.2 ADJUST AND CLEAN:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL:

- A. Prior to energization of switchgear and switchboards, check with ground resistance tester phase to phase and phase to ground insulation resistance levels to ensure requirements are fulfilled.
- B. Prior to energization, check switchgear and switchboards for electrical continuity of circuits, and for short circuits.
- C. Subsequent to wire and cable connections, energize switchgear and switchboard and demonstrate functioning in accordance with requirements.

END OF SECTION 26 2413

SECTION 26 2416

PANELBOARDS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to panelboards specified herein.

1.2 DESCRIPTION OF WORK:

- A. The extent of panelboard and enclosure work, is indicated by drawings and schedules.
- B. Types of panelboards and enclosures in this section include lighting and appliance panelboards, and power distribution panelboards.

1.3 QUALITY ASSURANCE:

- A. Provide units that have been UL listed and labeled. Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC pertaining to installation of wiring and equipment in hazardous locations. Comply with NEMA Stds. Pub No. 250, "Enclosures for Electrical Equipment (1000 volt maximum). Pub No. 1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide of one of the following:
 - 1. Cutler Hammer Products, Eaton Corp.
 - 2. GE/ABB
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D Company

2.2 PANELBOARDS:

- A. GENERAL:
 - 1. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated. Equip with number of unit panelboard devices as required for complete installation. Fully equip "spaces" with hardware to receive breaker or switch of size indicated. Provide CU/AL rated lugs of proper size to accommodate conductors specified.
- B. POWER DISTRIBUTION PANELBOARDS:
 - 1. Provide dead-front safety type power distribution panelboards as indicated, with switching and protective devices in quantities, ratings, types and with arrangement shown. Equip with copper bus bars, full-sized neutral bus and ground bus. Provide

fusible or circuit breaker branch and main devices as indicated. Series rated systems are not acceptable. See Section 262815, Overcurrent Protection Devices.

C. LIGHTING AND APPLIANCE PANELBOARDS:

1. Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types, and arrangement shown. Provide bolt-on thermal magnetic type branch breakers. Where multiple breakers are indicated, provide with common trip handle. Series rated systems are not acceptable. Equip with copper bus bars, full-sized neutral bus, and ground bus.

D. PANELBOARD ENCLOSURES:

1. Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage minimum 16-gage thickness. Provide door-in-door hinged fronts. Provide fronts with adjustable indicating trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges and door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Provide enclosures fabricated by same manufacturer as overcurrent devices contained therein Bolt engraved plastic laminate labels indicating panel name and voltage on the interior and exterior of panelboards.

E. FINISH:

1. Coat interior and exterior of surface with manufacturer's standard color; baked on enamel finish.

F. ELECTRICAL IDENTIFICATION:

1. Refer to Section 260553 for requirements.

PART 3 – EXECUTION

3.1 INSTALLATION OF PANELBOARDS:

A. GENERAL:

1. Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", in compliance with recognized industry practices to ensure products fulfill requirements.

B. MOUNTING:

1. Provide 4" high concrete curb under floor standing distribution panelboards.
2. Coordinate installation of panelboards and enclosures with cable and raceway installation work. Anchor enclosures firmly to walls and structural surfaces, ensuring they are permanently and mechanically secure. Arrange conductors neatly within enclosure, and secure with suitable nylon ties. Fill out panelboard's circuit directory card upon completion of installation work. Utilize actual final building room numbers, not architectural numbers used on drawings. Identify individual lighting circuits and individual receptacle circuits by room served. Label circuit breakers to identify location of subpanel or equipment supplied using room numbers and equipment names. Include room number with equipment circuit designations. All directories to be typewritten.

END OF SECTION 26 2416

SECTION 26 2713

SERVICE ENTRANCE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of service-entrance work is indicated by drawings and schedules.
- B. Switchboards, panels, disconnects, transformers, etc., used for service-entrance equipment are specified in applicable Division-26 sections, and are included as work of this section.
- C. Consult local utility relative to all costs for line extensions, connections, etc., and include all costs for bringing service to the facility in base bid. Confirm location of point of service before bidding.
- D. Provide labor and materials as required to accomplish power company metering in accordance with power company standards and requirements.

1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA standards as applicable to construction and installation of service-entrance equipment and accessories. Provide service-entrance equipment and accessories that are UL-listed and labeled, and equipment marked, "Suitable for use as Service Equipment".

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

- A. MAINTENANCE STOCK, FUSES: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 SERVICE - ENTRANCE EQUIPMENT:

- A. GENERAL: Provide service-entrance equipment and accessories, of types, sizes, ratings and electrical characteristics indicated, that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation, and as herein specified.

2.2 OVERCURRENT PROTECTIVE DEVICES:

- A. GENERAL: Provide overcurrent protective devices complying with Division-26 section "Overcurrent Protective Devices", and as indicated on drawings.

2.3 METERING:

- A. METER SOCKETS: Provide meter sockets that comply with requirements of local utility company supplying electrical power to service-entrance equipment of building project.

2.4 RACEWAYS AND CONDUCTORS:

- A. GENERAL: Provide raceways and conductors complying with applicable Division-26 Basic

Materials and Methods sections.

- B. WALL AND FLOOR SEALS: Provide wall and floor seals complying with Division-26 Basic Materials and Methods section "Raceways".

PART 3 – EXECUTION

3.1 INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT:

- A. Install service-entrance equipment as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that service-entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards.
- B. Coordinate with other work, including utility company wiring, as necessary to interface installation of service-entrance equipment work with other work.
- C. Install all floor standing service equipment on 4" high concrete curb and bolt equipment to curb with 3/8" anchors at each corner and at intervals not to exceed 8' along perimeter. Install concrete wiring trench under floor standing equipment; 12" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench.

3.2 GROUNDING:

- A. Provide system and equipment grounding and bonding connections for service-entrance equipment and conductors, as required.

3.3 ADJUST AND CLEAN:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.4 FIELD QUALITY CONTROL:

- A. Upon completion of installation of service-entrance equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION 26 2713

SECTION 26 2726

WIRING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK:

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems that are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this section include the following:
 - 1. Receptacles
 - 2. Cord caps
 - 3. Cord connectors

1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA standards as applicable to construction and installation of electrical wiring devices. Provide electrical wiring devices that have been UL listed and labeled.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 FABRICATED WIRING DEVICES:

- A. GENERAL:
 - 1. Provide factory-fabricated wiring devices, in types, and electrical ratings for applications indicated and complying with NEMA Stds. Pub No. WD 1.
- B. Provide wiring devices (of proper voltage rating) as follows:

	<u>RECEPTACLE</u>	<u>SWITCHES</u>			
<u>MFGR</u>		<u>1-POLE</u>	<u>3-WAY</u>	<u>4-WAY</u>	<u>W-PILOT</u>
Hubbell	HBL 5352	HBL 1221	HBL 1223	HBL 1224	HBL 1221-PL
Bryant	5352	1221	1223	1224	1221-PL
Pass Seymour	5352	20AC1	20AC3	20AC4	20AC1-RPL
Leviton	5362	1221	1223	1224	
Cooper	5352	1221	1273	1224	1221-PL

- C. Provide devices in colors selected by Architect. Provide red devices on all emergency circuits.

D. GROUND-FAULT INTERRUPTER:

1. Provide general-duty, duplex receptacle, ground-fault circuit interrupters; feed-thru types, capable of protecting connected downstream receptacles on single circuit; grounding type UL-rated Class A, Group A, 20-amperes rating; 120-volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 milliamperes ground-fault trip level; color as selected by Architect. Provide Hospital grade where required elsewhere by specification or drawings. Provide units of one of the following:
 - a. P&S/Sierra
 - b. Hubbell
 - c. Leviton
 - d. Square D

E. WEATHER-RESISTANT RECEPTACLES

1. Provide weather-resistant receptacles in outdoor locations such as under roofed open porches, canopies, marquees, etc.
2. Provide products of one of the following:
 - a. Pass & Seymour 2095TRWRXXX.
 - b. Hubbell GFTR20XX

F. CORD CAPS AND CONNECTORS:

1. Provide 3, 4 and 5-wire grounding, cap plugs, and connectors of ampere and voltage rating required, for final equipment, and as indicated otherwise on drawings.
2. Provide products of one of the following:
 - a. Cooper
 - b. General Electric
 - c. Hubbell
 - d. Leviton
 - e. P&S

2.2 WIRING DEVICE ACCESSORIES:

A. WALL PLATES:

1. Provide coverplates for wiring devices; plate color to match attached wiring devices. Provide nylon or Lexan coverplates in all finished areas. Provide galvanized steel plates in unfinished areas. Provide blank coverplates for all empty outlet boxes.

B. WEATHER-PROTECTING DEVICE ENCLOSURES:

1. Where required for compliance with NEC 406-8 (receptacles installed outdoors for use other than with portable tools or equipment), provide weather-tight device covers that provide complete protection with the cord and cap inserted into the wiring device. Provide units that mount on either single or double gang devices.
2. Provide products of one of the following for In Box Horizontal for brick and cast stone:
 - a. Arlington Industries

- i. DSHB1C Clear Cover
 - ii. DSHB1W White Cover
 - iii. DSHB1BR Brown Cover
 - iv. DSHB1BRC Brown Clear Cover
3. Provide products of one of the following for In Box Vertical or Horizontal for Stucco and Metal Sidings:
 - a. Arlington Industries
 - i. DSBVM1C Clear Cover
 - ii. DSBVM1W White Cover
 - iii. DSBHM1C Clear Cover
 - iv. DSBHM1W White Cover
4. Provide products of one of the following for roof mounted installations:
 - a. Intermatic WP1020 or WP1030
 - b. P&S WIUC10C or WIUC20c

PART 3 – EXECUTION

3.1 GENERAL

- A. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation" and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical box and wiring work, as necessary to interface installation of wiring devices with other work. Install devices in boxes such that front of device is flush and square with coverplate. Drawings are small scale and, unless dimensioned, indicate approximate locations only of outlets, devices, equipment, etc. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate with other work. Verify all dimensioned items on job site. Consult architectural cabinet, millwork, and equipment shop drawings before beginning rough-in of electrical work. Adjust locations of all electrical outlets as required to accommodate work in area, and to avoid conflicts with wainscoat, back splash, tackboards, and other items.
- C. Install wiring devices only in electrical boxes that are clean; free from excess building materials, dirt, and debris.
- D. Install blank plates on all boxes without devices.
- E. Delay installation of wiring devices until wiring work and painting is completed. Provide separate neutral conductor from panel to each GFI receptacle.
- F. Install GFI receptacles for all receptacles installed in the following locations:
 1. Restrooms, locker rooms, kitchens, within 6 feet of any sink, or when serving vending machines and electric drinking fountains.
 2. Indoor wet locations, non-dwelling garages, elevator rooms and pits.
 3. Outdoors, and on rooftops.
- G. Electrical Identification: Refer to Section 260553 for requirements.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES:

- A. At time of substantial completion, replace those items, that have been damaged, including those stained, burned and scored.

3.3 GROUNDING:

- A. Provide electrically continuous, tight grounding connections for wiring devices, unless otherwise indicated.

3.4 TESTING:

- A. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.

END OF SECTION 26 2726



SECTION 26 2815

OVERCURRENT PROTECTIVE DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to overcurrent protective devices specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of overcurrent protective device work is indicated by drawings and schedules and specified herein. Overcurrent protective devices specified herein are for installation as individual components in separate enclosures; and for installation as integral components of switchboard and panelboards. See Section 262413, Switchgear and Switchboards, and Section 262416, Panelboards.
- B. Types of overcurrent protective devices in this section include the following for operation at 600 Volts and below:
 - 1. Molded case thermal circuit breakers
 - 2. Fusible switches
 - 3. Fuses
- C. Refer to other Division-26 sections for cable/wire and connector work required in conjunction with overcurrent protective devices.

1.3 QUALITY ASSURANCE

- A. Comply with NEC requirements and NEMA and ANSI standards as applicable to construction and installation of overcurrent devices.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products of one of the following (main and branch device manufacturer must be same as panelboard and/or switchboard manufacturer):
- B. CIRCUIT BREAKERS AND FUSIBLE SWITCHES:
 - 1. Cutler Hammer Products, Eaton Corp.
 - 2. GE/ABB
 - 3. Square D Co.
 - 4. Siemens Energy and Automation
- C. MOLDED CASE THERMAL TRIP CIRCUIT BREAKERS:
 - 1. Provide factory-assembled, molded case circuit breaker for power distribution panelboards and switchboards; and for individual mounting, as indicated. Provide breakers of amperage, voltage, and RMS interrupting rating shown, with

permanent thermal trip and adjustable instantaneous magnetic trip in each pole. Series rated systems are not acceptable. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees C. Provide with mechanical screw type removable connector lugs, AL/CU rated, of proper size to accommodate conductors specified.

2. Circuit breakers 15 amps through 599 amps shall be molded case thermal trip circuit breakers.

D. FUSIBLE SWITCHES:

1. Provide factory-assembled fusible switch units for power distribution panelboards and switchboards, and individual mounting as indicated. Provide switch units of amperage, voltage, and RMS interrupting rating as shown, with quick-make, quick-break mechanisms, visible blades and dual horsepower ratings. Series rated systems are not acceptable. Equip with lockable handles with on-off indication. Interlock switch covers and handles to prevent opening in "ON" position. Provide switch with Class R rejection fuse clip kits. Provide AL/CU rated lugs of proper size to accommodate conductors specified.

2.2 FUSES

- A. GENERAL: Except as otherwise indicated, provided fuses of type, sizes and ratings and electrical characteristics of a single manufacturer as follows. Provide fuses labeled UL Class L or UL Class R, current limiting and rated for up to 200,000 amperes. Provide Buss KAZ signal activating fuses where required elsewhere in specification.
- B. Where fuses are shown feeding individual or groups of equipment items, comply with manufacturer's recommendation for fusing; adjust fuse size and type as necessary to comply with manufacturer's recommendation.
- C. Provide and install spare fuse cabinet in main electrical room.
- D. MAIN SERVICE AND FEEDER CIRCUITS: For fuse ratings over 600 amperes provide UL Class L Fuses (KRP-C, or A4BQ or LCL or KLPC). For fuse ratings up to 600 amperes, provide UL Class RK1 (KTN-R, KTS-R or A2K-R, A6K-R or NCCR, SCLR or KLN-R, KLS-R). If fuse directly feeds motors, transformers or other inductive load provide UL RK5 time delay (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECS-R or FLN-R, FLS-R).
- E. BRANCH CIRCUITS: For motor circuits, transformer circuits, or other inductive loads, provide UL Class RK5 (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECN-S or FLN-R, FLS-A). For other circuits, provide UL Class RK1, (KTN-R, KTS-R OR A2K-R, A6K-R or NCLR, SCLR OR KLN-R, KLSR).
- F. MANUFACTURER: Subject to compliance with requirements, provide fuses of one of the following:
 1. Bussman Mfg. Co.
 2. Mersen (Ferraz Shawmut)
 3. Reliance Fuse Div./Brush Fuse Inc.
 4. Littlefuse, Inc.

PART 3 – EXECUTION

3.1 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES:

- A. Install overcurrent protective devices as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices

comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.

- B. Coordinate with work as necessary to interface installations of overcurrent protective devices with other work.
- C. Install fuses in overcurrent protective devices. For motor circuits, fuse sizes shown on drawings are for general guidance only. Size fuses in accordance with fuse manufacturer's recommendation for given motor nameplate ampere rating. Test operation. If nuisance tripping occurs, increase fuse size and disconnect device (if necessary) as required to provide nuisance free tripping. Adjust fuse size properly for ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times. Include all costs in bid.
- D. After the switchgear is energized and just prior to Substantial Completion, the contractor shall ensure that the field-adjustable circuit breakers and solid-state circuit breakers and associated trip mechanisms have been set to the appropriate settings as recommended by the equipment Manufacturer (or as recommended by the electrical contractor's Protective Device Study if section 260573 has been included in the project). Time-current trip curves and trip setting information as was required in the Submittal portion of this specification shall be made available by the contractor at this time.
- E. Field test all ground fault protective devices for proper operation; test to be performed by representative of the manufacturer. Include verification of complete time current trip characteristics.
- F. Electrical Identification: Refer to Section 260553 for requirements.

3.2 FIELD QUALITY CONTROL

- A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

END OF SECTION 26 2815

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SECTION 26 2816

MOTOR AND CIRCUIT DISCONNECTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to motor and circuit disconnect switches specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of motor and circuit disconnect switch work is indicated by drawings and schedule. Work includes complete installations and electrical connections.

1.3 QUALITY ASSURANCE:

- A. Provide motor and circuit disconnect switches that have been UL listed and labeled. Comply with applicable requirements of NEMA Standards Pub. No. KS 1, and NEC.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. MANUFACTURER: Subject to compliance with requirements, provide products of one of the following (for each type of switch):
 - 1. Cutler Hammer Products, Eaton Corp.
 - 2. Square D Company
 - 3. GE/ABB
 - 4. Siemens Energy & Automation, Inc.

2.2 FABRICATED SWITCHES:

- A. GENERAL: Provide disconnect and safety switches as indicated herein. Provide:
 - 1. General duty switches on 240 Volt rated circuits.
 - 2. Heavy duty switches on 480 volt rated circuits.
 - 3. HP rated switches on all motor circuits.
- B. GENERAL DUTY SWITCHES: Provide general-duty type, sheet-steel enclosed switches, fusible or non-fusible as indicated of types, sizes and electrical characteristics indicated; rated 240 volts, 60 hertz; incorporating spring assisted, quick-make, quick-break mechanisms. Provide single phase or three phase and with solid neutral as required by application. Equip with operating handle that is capable of being padlocked in OFF position. Provide NEMA 1 or NEMA 3R as required by application, unless noted. Provide fusible switches with Class R rejection fuse clip kits.
- C. HEAVY-DUTY SWITCHES: Provide heavy-duty type, sheet-steel enclosed safety switches, fusible or non-fusible as indicated, of types, sizes and electrical characteristics indicated; rated 600 volts, 60 hertz; incorporating quick-make, quick-break type

mechanisms. Provide single phase or 3 phase, and with solid neutral as required by application, Equip with operating handle that is capable of being padlocked in OFF position. Provide NEMA 1 or NEMA 3R as required by application unless noted. Provide fusible switches with Class R rejection fuse clip kits.

- D. FUSES: Provide fuses for switches, as required of classes, types and ratings needed to fulfill electrical requirements for service indicated. See Section 262815 Overcurrent Protective Devices for fuse types. Refer to Section 26 0502 for requirements.
- E. Electrical Identification: Refer to Section 260553 for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES:

- A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Install disconnect switches used with motor driven appliances, and motors and controllers within sight of controller position.
- D. For disconnect switches serving motors controlled by variable frequency drives, provide late-make, early-break auxiliary contacts on each disconnect switch. Provide Heavy-Duty switch. Wire auxiliary contact to VFD safety contact, such that disconnecting the motor will shut down the drive first, and closing the switch will start the drive only after power is applied to the motor.

END OF SECTION 26 2816

SECTION 26 2913

MOTOR STARTERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of Division-26 sections making reference to motor starters specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of motor starter work is indicated by drawings and schedules.
- B. Types of motor starters in this section include the following:
 - 1. AC Fraction Horsepower Manual Starters
 - 2. AC Line Voltage Manual Starters
 - 3. AC Non-Reversing Magnetic Starters
 - 4. AC Combination Non-Reversing Magnetic Starters

1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA Standards as applicable to wiring methods, construction and installation of motor starters. Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units that have been UL-listed and labeled.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

- A. Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):
 - 1. Allen-Bradley Co.
 - 2. Appleton Electric Co.
 - 3. Crouse-Hinds Co.
 - 4. Eaton Corp., Cutler Hammer Products
 - 5. GE/ABB
 - 6. Siemens Energy & Automation, Inc.
 - 7. Square D Co.
- B. MAINTENANCE STOCK, FUSES: Refer to Section 26 0502 for requirements.

2.2 MOTOR STARTERS:

- A. GENERAL: Except as otherwise indicated, provide motor starters and ancillary components; of types, sizes, ratings and electrical characteristics indicated that comply with manufacturer's standard materials, design and construction in accordance with

published information and as required for complete installations.

- B. THERMAL OVERLOAD UNITS: Provide thermal overload units, sized to actual running full load current, not to motor plate current. Size heaters for mechanical equipment after air and water balancing have been completed.
- C. AC FRACTIONAL HP MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide manual, single-phase, 1 and 2 pole, 300 volt AC max, fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with one piece thermal overload relay with field adjustment capability of plus or minus 10 percent of nominal overload heater rating; for protection of AC motors of 1 HP and less. (For manually controlled motors in excess of 1 HP, see Line Voltage Manual Starters specified herein). Provide starter with quick-make, quick-break trip free toggle mechanisms, green pilot lights, and with lock-off toggle operated handle. Mount surface units in NEMA 1 enclosures, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location unless noted otherwise. Provide flush mounted units with coverplate to match wiring device coverplates.
- D. AC LINE VOLTAGE MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide line voltage manual starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt AC max; equip with pushbutton operator, low voltage protection feature, and green pilot light. Provide starters with trip free mechanism such that contacts will open under load and remain open until thermal element has cooled, and unit is reset. Mount surface units in NEMA 1 enclosure, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location, unless noted otherwise. Provide overlapping trim for flush mounted units.
- E. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8538): Provide line voltage combination starters, of types, ratings, and electrical characteristics; 2 or 3 pole, 600 volt maximum with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with fusible disconnect switch. Provide quick-make, quick-break, disconnect for NEMA sizes 1, 2, 3, and 4; and visible blade, automatic circuit interrupters with push-to-trip feature and separate fuse clips for larger NEMA sizes. Fuse all starters with dual-element (time-delay) fuses equal to Bussman FRN/FRS-R. Equip disconnect switch with Class R rejection fuse kits. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide combination starters for individual mounting, or for group mounting in motor control centers as indicated. Provide NEMA 1 enclosures unless otherwise indicated. Provide NEMA 3R enclosure in exterior or damp locations, unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS:

- A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Install fuses in fusible disconnects, if any. Mount chart inside each starter indicating heater type, size, and ampere ratings available.
- C. Electrical Identification: Refer to Section 260553 for requirements.

3.2 ADJUST AND CLEAN:

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL:

- A. Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION 26 2913



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SECTION 26 4119

DEMOLITION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Special Provisions, Division 1 and Division-2 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to demolition.

1.2 DESCRIPTION OF WORK:

- A. Extent of major items of demolition work is indicated by drawings. Other demolition work shall be performed as required to maintain system operation.
- B. The intent of the drawings is to indicate major items affected and not to show every device, outlet, fixture, etc. affected by demolition work.
- C. The drawings do not necessarily reflect as-built conditions. The contractor shall visit the jobsite prior to bidding to determine the overall scope of demolition work.
- D. Refer to sections of other Divisions for applicable requirements affecting demolition work.
- E. Refer to Section 260500 for requirements with regard to power outages affecting the operation of existing electrical systems.

1.3 QUALITY ASSURANCE:

- A. NEC COMPLIANCE:
 - 1. Comply with applicable portions of NEC as to methods used for demolition work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL:

- A. Demolition work shall be laid out in advance to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary, perform with care, use skilled mechanics of the trades involved. Repair damage to building and equipment. Cutting work of other Contractors shall be done only with the consent of that Contractor. Cutting of structural members shall not be permitted.

3.2 PATCHING AND REPAIR

- A. The Contractor is responsible for all demolition, patching and repair of all finished interior surfaces pertaining to the installation of this particular phase of work. All surfaces shall be finished (painted, etc.) to match the adjacent materials, finishes and colors.
- B. Hard surfaces: Whenever demolition or excavation is required for the installation of the electrical system, it shall be the responsibility of this contractor to make repairs and/or

replacements of hard finish surfaces such as concrete, asphalt, roofing, etc.

- C. The method of patching and repair shall follow good construction practices and all finished surfaces shall match materials and finish wherein the demolition occurred.

3.3 EXISTING EQUIPMENT

- A. The following is a part of this project and all costs pertaining thereto shall be included in the base bid.
- B. The new electrical equipment and apparatus shall be coordinated and connected into the existing system as required. Auxiliary systems shall comply, unless otherwise specified.
- C. The existing electrical devices, conduit and/or equipment that for any reason obstructs construction shall be relocated. Provide conduit, wiring, junction boxes, etc. as required to extend existing circuits and systems to relocated devices or equipment.
- D. The new fixtures indicated for existing outlets shall be installed in accordance with the fixture specifications.
- E. When installing equipment in the existing building, it shall be concealed.
- F. All existing electrical equipment and systems in portions of the building not being remodeled shall be kept operational, in service and in working condition throughout the entire construction period. Restore any circuits and systems interrupted. Provide temporary panels, temporary wiring and conduit, etc. as required.
- G. Maintain circuit integrity and continuity of all existing circuits and systems that interfere with or are interrupted by remodel work unless those circuits are to be abandoned completely. Maintain all circuits and systems in operation during construction. Provide temporary panels, temporary wiring and conduit, etc. as required.
- H. Existing raceways may be used where possible in place, except as noted. All circuits, conduit and wire that are not used in the remodeled area shall be removed back to the panelboard, where it shall be labeled a spare with circuit number indicated. Re-used raceway shall meet all requirements for new installations.
- I. Obtain permission from the Architect and Owner's representative before penetrating any ceiling, floor, and wall surfaces.
- J. Any and all equipment having electrical connections that require disconnecting and reconnection at the same or another location throughout the course of construction shall be included as part of this contract.

END OF SECTION 26 4119