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PROJECT MANUAL

EMA PROJECT NO. 1 001 0847 001

FEBRUARY 14, 2022

2022 DISTRICT WIDE ESSER HVAC RENOVATIONS TO MULTIPLE CAMPUSES MOUNT PLEASANT INDEPENDENT SCHOOL DISTRICT

MR. JUDD MARSHALL
SUPERINTENDENT

ENGINEER:
EMA ENGINEERING & CONSULTING
328 SOUTH BROADWAY AVENUE
TYLER, TEXAS 75702
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REGISTRATION NO. F-893

SEALS PAGE

EMA PROJECT NO. 1 001 0847 001

ENGINEER: **EMA Engineering & Consulting**
328 South Broadway Avenue
Tyler, Texas 75702
903.581.2677 (Phone)

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DIVISION 0 - BIDDING AND CONTRACT REQUIREMENTS

SECTION 00 02 00 - INVITATION TO BID

PROJECT: 2022 DISTRICT WIDE ESSER HVAC RENOVATIONS
TO MULTIPLE CAMPUSES
MOUNT PLEASANT INDEPENDENT SCHOOL DISTRICT

PROJECT NUMBER: 1 001 0847 001

BID DATE AND TIME: March 10, 2022, 2:00pm

Opening Of Bids: Mount Pleasant Independent School District
2230 North Edwards Ave
Mount Pleasant, Texas 75455

ENGINEER: EMA Engineering & Consulting
328 South Broadway Avenue
Tyler, Texas 75702 (Phone: 903-581-2677)

The Mount Pleasant ISD Board of Trustees has selected competitive sealed proposals as the project delivery/contract method to be used for this project.

Competitive Sealed Proposals are requested for the ***2022 District Wide ESSER HVAC Renovations to Multiple Campuses Mount Pleasant Independent School District***.

Scope of work includes: HVAC Renovations and Indoor Air Quality Improvements.

Sealed proposals will be received by Mount Pleasant ISD at the following location: Administration 2230 North Edwards Ave Mount Pleasant, Texas 75455. Proposals received after bid date and time will not be accepted. All interested parties are invited to attend. Proposals will be opened publicly and read aloud.

Electronic drawings and specifications may be obtained from the Mount Pleasant Independent School District website.

Bid Security in the amount of 5% of proposal must accompany each bid in accordance with the Instructions to Bidders. The successful bidders shall provide Payment and Performance Bonds.

All Contractors shall comply with prevailing wage rates in accordance with the civil statutes of the State of Texas and Department of Labor.

Davis-Bacon Act requires payment of prevailing wages to various classes of laborers and mechanics. Certified payrolls are required for this project and shall comply with U.S. Department of Labor Form WH-347.

The Owner reserves the right to waive irregularities and to reject any or all Bids. The Mount Pleasant Independent School District reserves the right to separate or eliminate any item it deems necessary to accommodate budgetary and/or operational requirements. The Mount Pleasant Independent School District also reserves the right to reject any or all Bids or parts of the Bids, and waiver all

formalities, and to award this Bid in the best interest of the Mount Pleasant Independent School District. The Mount Pleasant Independent School District also reserves the right to award to other than the lowest bidder under statutory mandate 2267.055 Government Code.

The General Contractor shall be a Mechanical Contractor and shall have been in business seven continuous years under the company bidding this project. Specific related school experience is required. All Bidders shall visit the job site before submitting bid. Bid Bond, Performance Bond, and Labor and Material Payment Bond are required of the General Contractor.

The Mechanical Contractor shall be required to provide Bid Bond and Payment and Performance Bond as specified herein.

See qualifications of Mechanical Contractor in specifications.

The Bid Security will not be returned until all bonds are provided.

The successful bidder shall be required to attend the pre-construction conference prior to the beginning of the work.

Bidders shall submit a detailed schedule of construction as well as a staffing plan. Bidders shall define continency measures if there are delays in equipment orders that prevent the project completion on schedule.

SELECTION CRITERIA: In accordance with Texas Education Code as amended, Mount Pleasant Independent School District shall evaluate all proposals based on a combination of factors that the MPISD determines provides the best value to the District including:

1. Price;	35 points
2. Proposer's experience and reputation;	30 points
3. Proposer's past performance and quality of work;	5 points
4. Proposer's personnel to be assigned to the project;	5 points
5. Conformance with proposed contract document requirements;	5 points
6. Proposed warranty coverage;	15 points
7. Impact on the ability of the district to comply with existing	5 points
a. laws related to historically underutilized, women owned,	
b. small, or disadvantaged businesses.	

A Pre-Bid Conference will be held February 22, 2022, at 10:00 a.m., at the Mount Pleasant Independent School District Administration Building. It is highly recommended that companies submitting proposals attend.

Mount Pleasant ISD encourages the participation of qualified historically underutilized businesses.

Mount Pleasant Independent School District
Judd Marshall
Superintendent

SECTION 00 10 00

INSTRUCTIONS TO BIDDERS

IN THIS ENTIRE DOCUMENT, THE TERM “BID” SHALL MEAN “PROPOSAL” AND THE TERM “BIDDER” SHALL MEAN “PROPOSER”.

1. Defined Terms.

Terms used in these Instructions to Bidders which are defined in the Standard General Conditions of the Construction Contract (No. 1910-8, 1996 ed.) have the meanings assigned to them in the General Conditions. The term "Bidder" means one who submits a Bid directly to Owner, as distinct from a sub-bidder, who submits a bid to a Bidder. The term "Successful Bidder" means the lowest, qualified, responsible and responsive Bidder to whom Owner (on the basis of Owner's evaluation as hereinafter provided) makes an award. The term "Bidding Documents" includes the Advertisement or Invitation to Bid, Instructions to Bidders, the Bid Form, and the Contract Documents (including all Addenda issued prior to receipt of Bids).

2. Electronic Copies of Bidding Documents.

2.1. Bidders may obtain complete sets of the Bidding Documents electronically from the link provided in the INVITATION TO BID (Section 00 02 00-1) and from the Plan Rooms.

2.2. Complete sets of Bidding Documents must be used in preparing Bids, neither Owner nor Engineer assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

2.3. Owner and Engineer in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids on the Work and do not confer a license or grant for any other use.

3. Qualifications of Bidders.

3.1 The Mechanical Contractor (Bidder) shall have been in business for seven continuous years under the company name bidding this project. Specific related school experience is required. See additional qualifications/requirements in paragraph 15 in this section.

3.2. The Owner reserves the right to reject any Bid if the evidence submitted by, or investigation of, such Bidder fails to satisfy the Owner that such Bidder is properly qualified to carry out the obligations of the Contract and to complete the Work contemplated. Conditional Bids will not be accepted. The successful Bidder will be required to execute an Agreement Between Owner and Contractor, which together with the other Contract Documents shall form the Contract.

3.2.1. In order for a bidder to be eligible to receive consideration on this project, he must, if requested by Owner, pre-qualify his capabilities on the basis of financial status, experience and type of work previously completed. Forms: Pre-qualification data must be typewritten (one copy). All information will be held in strictest confidence. The submission of pre-qualification data will not be required of a bidder, providing that bidder has submitted adequate qualification information that has been approved for previous school work with Mount Pleasant Independent School District. In the "Award of Contracts", consideration will be given to past performance of bidders.

3.3. Bidders shall submit with the proposal a notarized Contractor's Qualification Statement on A.I.A. Document A305 regarding the qualifications of the bidder. Provide seven references (minimum) of related public school work. Include project, school contact (name/address/phone number), and Engineer (name/address/phone number). Section 16.0 pertaining to the firm's audited financial statement may be withheld until such time it is specifically requested in writing by the Engineer or Owner. If requested, Bidder shall submit financial ability to carry on the work until such time as to receive the first payment on their contract, to finance the work between payments until contracts are complete and accepted, and to finance the warranty work.

3.3.1. Bidders shall also obtain and submit, within 24 hours of the receipt of a written request from the Engineer or Owner, notarized Contractor's Qualification Statements on AIA Document A305 regarding the qualifications of the major subcontractors proposed for use in the work. Section 16.0 pertaining to the firm's audited financial statement may be withheld until such time it is specifically requested in writing by the Engineer or Owner.

3.3.2. Bidders shall submit in writing with the proposal, on the form provided with the Proposal Form, the names of Subcontractors proposed for use in the work.

4. Examination of Contract Documents and Site.

4.1. It is the responsibility of each Bidder before submitting a bid, to (a) examine the Contract Documents thoroughly, (b) visit the site to become familiar with local conditions that may affect cost, progress, performance, or furnishing of the Work, (c) consider federal, state and Local Laws and Regulations that may affect cost, progress, performance or furnishing of the Work, (d) study and carefully correlate Bidder's observations with the Contract Documents, and (e) notify Engineer of all conflicts, errors or discrepancies in the Contract Documents. Bidders and Sub-Bidders shall promptly notify the Engineer of any ambiguity, inconsistency or error which they may discover upon examination of the Bidding Documents or of the site and local conditions. Contractors will not be given extra payments for conditions which can be determined by examining the site and documents.

4.2. Information and data reflected in the Contract Documents with respect to Underground Facilities at or contiguous to the site is based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities or others, and Owner does not assume responsibility for the accuracy or completeness thereof unless it is expressly provided otherwise.

4.3. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders on subsurface conditions, Underground Facilities and other physical conditions, and possible changes in the Contract Documents due to differing conditions appear in Paragraphs 4.2 and 4.3 of the General Conditions.

4.4. Before submitting a Bid, each Bidder will, at Bidder's own expense, make or obtain any additional examinations, investigations, exploration, tests and studies and obtain any additional information and data which pertain to the physical conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the Work in accordance with the time, price and other terms and conditions of the Contract Documents.

4.5. On request in advance, Owner will provide each Bidder or Sub-Bidder access to the site to conduct explorations and tests as each Bidder deems necessary for submission of a bid. Bidder or Sub-Bidder shall fill all holes, clean up and restore the site to its former condition upon completion of such explorations.

4.6. The lands upon which the Work is to be performed, rights-of-way and easements for access thereto and other lands designated for use by Contractor in performing the Work are identified in the Contract Documents. All additional lands and access thereto required for temporary construction facilities or storage of materials and equipment are to be provided by Contractor.

4.7. The submissions of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 4, that without exception the Bid is premised upon performing and furnishing the Work required by the Contract Documents and such means, methods, techniques, sequences or procedures of construction as may be indicated in or required by the Contract Documents, and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

5. Interpretations and Addenda.

5.1. All questions about the meaning or intent of the Contract Documents are to be directed to the Engineer in writing. Interpretations or clarifications considered necessary by the Engineer in response to such questions will be issued by Addenda mailed, faxed, or delivered to all parties known by the Engineer as having received a complete set of the Bidding Documents. Questions received less than ten days prior to the date for opening of Bids may not be answered. Only questions answered by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect. The Owner and Engineer will not be responsible for oral clarifications.

5.2. Addenda may also be issued to modify the Bidding Documents as deemed advisable by Owner or Engineer.

5.3. Each Bidder shall ascertain prior to submitting his bid that he has received all Addenda issued, and he shall acknowledge their receipt in his Bid.

6. Bid Security.

6.1. Bids shall be accompanied by a cashier's check or certified check drawn upon a state bank in the amount not less than five percent (5%) of bid payable without recourse to the Mount Pleasant Independent School District or a bid bond in the same amount from a reliable surety company licensed to do business in the State of Texas and listed in the current Federal Register, as a guarantee that the bidder will enter into a contract and execute payment and performance bond within fifteen (15) days after notice of award of the contract to him.

6.2. Bid Bonds may be submitted on the form(s) normally used by the Bidders Surety. The bond must be accompanied by a current copy of the power of attorney authorizing the attorney-in-fact who executes the bond. The Surety Company must be authorized to do business under a Certificate of Authority issued by the State of Texas and hold Certificates of Authority as an acceptable Surety on the current Department of the Treasury Listing as found in the Federal Register.

7. Contract Time.

The numbers of days within which, or the dates by which, the Work is to be substantially completed and also completed and ready for final payment (the Contract Time) are set forth in the Bid Form and the Agreement.

8. Substitute or "Or-Equal" Items.

The materials and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by any proposed substitution. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cut sheets, performance and test data and any other information necessary for an evaluation. A statement setting forth any changes in other materials, equipment or Work that incorporation of the substitute would require shall be included. The burden or proof of the merit of the proposed substitute is upon the Bidder. The Engineer's decision of approval or disapproval of a proposed substitution shall be final. Substitution of products to be equal to those specified herein will be considered only when the following requirements have been met:

> A complete list of proposed substituted products, in duplicate, shall be submitted to the Engineer. Submittals shall be received by the Engineer as required in Divisions 1, 2, 15, and 16. Submittals shall provide satisfactory products which are, in fact, equal in quality, performance, maintainability, demonstrated reliability, complexity, user friendliness, and demonstrated support service to those specified herein.

9. Subcontractors, Suppliers and Others.

9.1. The Bidder will be required to establish to the satisfaction of the Engineer and the Owner the reliability and responsibility of the persons or entities proposed to furnish and perform the Work described in the Bidding Documents.

9.2. Prior to the award of the Contract, the Engineer will notify the Bidder in writing if either the Owner or the Engineer, after due investigation, has reasonable objection to any such proposed person or entity. If the Owner or Engineer has reasonable objection to any such proposed person or entity, the Bidder may, at his option, (1) withdraw his Bid, or (2) submit an acceptable substitute person or entity with an adjustment in his bid price to cover the difference in cost occasioned by such substitution. The Owner may, at his discretion, accept the adjusted bid price or he may disqualify the Bidder. In the event of either withdrawal or disqualification, under this Subparagraph, bid security will not be forfeited, notwithstanding the provisions of Paragraph 12.2.

9.3. Persons and entities proposed by the Bidder and to whom the Owner and the Engineer have made no reasonable objection under the provisions of Subparagraph 9.2 must be used on the Work for which they were proposed and shall not be changed except with the written consent of the Owner and the Engineer.

9.4. No Contractor shall be required to employ any Subcontractor, Supplier, other person or organization against whom Contractor has reasonable objection.

10. Bid Form.

10.1. The Bid Form is included with the Bidding Documents.

10.2. All blanks on the Bid Form must be completed in ink or by typewriter.

10.3. Where so indicated by the make-up of the bid form, sums shall be expressed in both words, and figures, and in case of discrepancy between the two, the amount written in words shall govern.

10.4. Any interlineation, alteration or erasure must be initialed by the signer of the Bid.

10.5. All requested Alternates shall be bid. If no change in the Base Bid is required, enter "No Change".

10.6. Each copy of the Bid shall include legal name of the Bidder and a statement that the Bidder is a sole proprietor, a corporation, or some other legal entity. Each copy shall be signed in ink by the person or persons legally authorized to bind the Bidder to a contract. A Bid by a corporation shall further give the state of incorporation and have the corporate seal affixed and attested by the secretary or the assistant secretary. A Bid submitted by an agent shall have a current power of attorney attached certifying the agent's authority to bind the Bidder. Bids by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature and the official address of the partnership must be shown below the title.

10.7. All names must be typed or printed below the signature.

10.8. The Bid shall contain an acknowledgment of receipt of all Addenda (the numbers of which must be filled in on the Bid Form).

10.9. The address and telephone number for communications regarding the Bid must be shown.

11. Submission of Bids.

11.1. Bids, Bid Security, and other documents required to be submitted shall be submitted at the time and place as advertised in the Invitation to Bid.

11.2. Each Bid must be submitted on an unaltered proposal form furnished by the Engineer and addressed as provided in the Invitation to Bid.

11.3. Each bid must be submitted in a sealed envelope bearing on the outside (lower left corner) the name of the bidder, his address, the type of work, and the name of the project for which the bid is submitted and the bid number. If forwarded by mail, the sealed envelope containing the bid must be enclosed in another envelope addressed as specified in paragraph 11.2. above with the notation "Bid Enclosed" on the face of it. Identify project, bid date, bid number, and bid time on outside of the envelope. No responsibility will be attached to any officer for the premature opening of a bid not properly addressed and identified.

11.4. Bids shall be deposited at the designated location prior to the time and date for receipt of Bids indicated in the advertisement or Invitation to Bid, or any extension thereof made by Addendum. Bids received after the time and date for receipt of Bids will be returned unopened.

11.5. The Bidder shall assume full responsibility for timely delivery at the location designated for receipt of Bids. Any bid forwarded by mail should be mailed in sufficient time to be received at the opening date and time.

11.6. Oral, faxed, telephonic or telegraphic Bids are invalid and will not receive consideration.

11.7. Each Bidder by making his Bid represents that:

11.7.1. The Bidder has read and understands the Bidding Documents and their Bid is made in accordance therewith.

11.7.2. The Bidder has visited the site, has familiarized themselves with the local conditions under which the Work is to be performed and has correlated their observations with the requirements of the proposed Contract Documents.

11.7.3. The Bidder Bid is based upon the materials, systems, and equipment required by the Bidding Documents without exception.

12. Modification and Withdrawal of Bids.

12.1. Bids may be modified or withdrawn by an appropriate document duly executed (in a manner that a Bid must be executed) and delivered to the place where Bids are to be submitted at any time prior to the opening of Bids.

12.2. A Bid may not be modified, withdrawn or canceled by the Bidder during the stipulated time period following the time and date designated for the receipt of Bids, and each Bidder so agrees in submitting his Bid.

13. Opening of Bids.

Properly identified bids received on time will be publicly opened and read aloud. An abstract of the amounts of the base Bids and major alternates (if any) will be made available to Bidders.

14. Bids to Remain Subject to Acceptance.

All bids remain subject to acceptance for sixty days after the day of the Bid opening.

15. Award of Contract.

15.1. The Contract will be awarded to the lowest and/or best qualified responsible Bidder as determined by the Owner. The Owner reserves the right to accept any of the bids, or parts of the bids submitted or to reject all bids, or parts of the bids, and to waive any irregularities or informalities in any bid as the Owner's interests are best served. The Owner reserves the right to separate or eliminate any item(s) it deems necessary to accommodate budgeting and/or operational requirements. The Owner also reserves the right to award to other than the lowest bidder under statutory mandate 271.027(b) Local Government Code. In determining who is the lowest and/or best qualified responsible Bidder, in addition to price, the Owner shall consider:

15.1.1. The quality, availability, and adaptability of the supplies, materials, equipment and contractual services, to the particular use required and possession of the necessary facilities, equipment, and bonding; previous performance; promptness, history of completions.

15.1.2. The number and scope of conditions attached to the proposal.

15.1.3. The experience, ability, capacity and skill of the Bidder to perform the Contract or perform the service required.

15.1.4. Whether the Bidder can perform the Contract or provide the service promptly, or within the time required, without delay or interference.

15.1.5. The character, responsibility, integrity, honesty, reputation, and experience of the Bidder.

15.1.6. The quality of performance of previous contracts or services.

15.1.7. The previous and existing compliance by the Bidder with law as relating to the Contract or service.

15.1.8. Any previous or existing noncompliance by the Bidder with specification requirements relating to time of submission of specific data such as samples, drawings, certificates, or other information.

15.1.9. The sufficiency of the financial resources and ability of the Bidder to perform the Contract or provide the service. Financial capacity; business judgment.

15.1.10. The ability of the Bidder to provide future maintenance, repair parts, and service for use of the subject of the Contract.

15.1.11. The compliance of the bids with the prescribed requirements, and such alternates, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

15.1.12. Education/School Facility Experience of Mechanical Contractor.

15.1.13. Meeting the published specifications.

15.1.14. Any other factor which could reasonably be asserted as being relevant to successful performance; as well as the safety record of the bidder, 271.0275 Local Government Code.

15.2. Owner may conduct such investigations as Owner deems necessary to assist in the evaluation of any Bid to establish the responsibility, qualifications and financial ability of Bidders, proposed Subcontractors, Suppliers and other persons and organizations to perform and furnish the Work in accordance with the Contract Documents to Owner's satisfaction within the prescribed time.

15.3. If the Contract is to be awarded, it will be awarded to the lowest Bidder whose evaluation by Owner indicates to Owner that the award will be in the best interests of the Project. The Owner shall have the right to accept Alternates in any order or combination, unless otherwise specifically provided and to determine the low Bidder on the basis of the sum of the Base Bid and the Alternates accepted.

15.4. If the contract is to be awarded, Owner will give the Successful Bidder a Notice of Award within sixty days after the day of the Bid opening.

15.5. The Owner shall have the right to reject any or all Bids and to reject a Bid not accompanied by any required bid security, or by other data required by the Bidding Documents, or to reject a Bid which is in any way incomplete or irregular.

16. Performance Bond & Payment Bond.

16.1. Contractor shall furnish a Performance and Payment Bond for 100% of the value of the work. The Performance and Labor and Material Payment Bond(s) shall be prepared on a form acceptable to the Owner and must identify compliance with the provisions of Article 5160 of the Revised Civil Statutes of Texas and state that all liabilities of the bond(s) shall be determined in accordance with the provisions of said Article. The Surety Company must be authorized to do business under a Certificate of Authority issued by the State of Texas and hold Certificates of Authority as an acceptable Surety on the current Department of the Treasury listing as found in the Federal Register. The bond company's main headquarters shall be in the continental United States.

Mechanical Contractor shall provide bonds. General Contractor shall deliver these bonds to Engineer for transmittal to the Owner.

16.2. The bidder shall deliver the required bonds to the Owner no later than the date of execution of the Contract.

16.3. The cost of the Bonds and Securities shall be included in the bid.

16.4. The Bidder shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of his power of attorney.

17. Form of Agreement Between Owner and Contractor.

17.1. The agreement for the work will be written on EJCDC Document 1910-8-A-1 (1996 Edition), Standard Form of Agreement Between Owner and Contractor on The Basis of A Stipulated Price. Payments will be made according to Owner policy. The contract between the Owner and the Contractor shall provide for progress payment on 95% of the labor performed and materials built into the work. Requests for payments shall be submitted to the Engineer. After completion date no partial or progress payments will be paid until all work is 100% complete and accepted by Owner and Engineer.

18. Sales Tax.

The materials incorporated in this project will be exempt from the limited sales, excise and use tax of the State of Texas, all in accordance with Ruling No. 9 as amended.

19. Prevailing Rates of Wages.

Mount Pleasant ISD has ascertained the General Prevailing rate of Per Diem Wages for each craft of type of workman or mechanic, and has also ascertained the prevailing rate for legal holiday and overtime work. Wages for this project will be paid in accordance with The Davis-Bacon Wage Act. The successful Bidder and any subcontractor(s) under him shall pay no less than the aforesaid rates. Nothing herein shall prevent the payment of an amount greater than such rates. The provisions of Article 5159a of the Texas Revised Civil Statutes Annotated as presently in effect or hereafter amended, are incorporated herein by reference in their entirety. The Bidders by submitting their respective proposals acknowledge the penalty provisions therein, and the successful Bidder for himself and each Subcontractor under him shall keep an accurate record showing the name, social security number, occupation by specific trade classification and level as set out in the Davis-Bacon Prevailing Rate of Per Diem Wage, hours worked, and actual wages and other benefits paid to each laborer, workman, mechanic and other person covered by said Article 5159a, and shall

provide the Owner with Certification thereof with each request for Payment.

20. Indemnification.

20.1. The Bidder does hereby agree that, if awarded the Contract, he shall indemnify and hold harmless the Mount Pleasant ISD and the Board of Trustees, its members, and employees and agents and consultants of the District from all suits and actions of every nature and description brought against them or any of them growing out of any contract, or contracts, written or oral, entered into between the District and the successful Bidder, whether covered by insurance or not, and further, that upon the awarding of the Contract to the successful Bidder in accordance with these specifications this agreement of indemnification shall automatically become effective.

20.2. The successful Bidder shall defend any and all suits brought against the District by any employee or other person (whether employed by the Bidder or not) for damage to property and/or injury to persons (including death) alleged or claimed to have been caused by or through the performance of the Bidder of the Work, and shall indemnify and hold harmless the District and the District's Consultants from and against any and all claims arising out of Work performed by the Bidder, including damage to the building and other property of the District and including all damage for the obstruction of private driveways, streets, and alleys, and all cost expenses of suits and reasonable attorney's fees, whether covered by insurance or not. In the event of any such injury (including death) loss or damage (or claim or claims thereof) the successful Bidder shall give immediate notice thereof to the District.

20.3. The successful Bidder will be required to provide insurance as set forth in the specifications and the Contract between the Owner and Contractor. However the indemnification required as set forth in the Contract Documents will be effective without regard to the availability of insurance to the Contractor. Liability to the Contractor is not limited to the availability of insurance or to the limits that are specified therein. These provisions of indemnification are in addition to and not in lieu of, the general conditions, the supplementary conditions or any amendments thereto as set forth in the general Contract.

21. Compliance with Antitrust Laws.

By submitting a proposal, each bidder thereby certifies that neither he/she nor the firm, corporation, partnership, or institution represented by the Bidder, or anyone acting for such firm, corporation, or institution has violated the Antitrust Laws of this state codified in Section 15.01 st. seq. of the Texas Business and Commerce Code, or the Federal Antitrust Laws, nor communicated directly or indirectly the proposal or bid made to any competitor or any other person or entity in such line of business.

22. Each and every Contractor and Subcontractor shall maintain all required insurance, including full workers' compensation coverage during the life of the Contract and until Mount Pleasant Independent School District has assumed the necessary insurance coverage. The Contractor's insurance company shall be licensed to do business in the State of Texas and maintain home offices in the Continental United States. Insurance Company must also be listed in the Federal Register, Part II, Circular 570, latest edition. Insurance Company must have an A.M. Best Rating of B+ VI or better.

23. Do not commence work under this contract until all insurance has been approved by Mount Pleasant Independent School District. Submit one (1) copy of coverage policies.

24. Mount Pleasant Independent School District shall issue an official Mount Pleasant Independent School District Purchase Order to the successful contractor. A duplicate copy of the Purchase Order will serve as an acknowledgment form and provisions will be made on this form for the Contractor to sign and return to the Purchasing Department within five (5) days of postmark date.

25. All operating and maintenance manuals, bulletins, instruction brochures, guarantees, etc., shall be given to the Engineer.

26. Pre-Bid Contractor Inspection: All contractors shall identify themselves at the school office PRIOR to touring the site.

27. Use of any tobacco products on any school campus or in any school building is prohibited pursuant to Mount Pleasant Independent School District Policy DH-LOCAL, CKD-LOCAL, and GKA-LOCAL, effective August 1, 1993.

28. The Owner's representative is Mr. Russell Luck, Director of Maintenance & Operations, Mount Pleasant ISD, 2230 N. Edwards Ave, Mount Pleasant, Texas 75455 (Phone: 903-575-2000).

29. The addresses of the sites are as follows:

Mount Pleasant Junior High School
2801 Old Paris Road
Mount Pleasant, Texas 75455

Wallace Middle School
504 Dunn Avenue
Mount Pleasant, Texas 75455

Frances Corprew Elementary School
909 School Street
Mount Pleasant, Texas 75455

30. General Description of Work:

This work includes but is not limited to the following. All work shall be complete and turn-key.

New HVAC equipment and Energy Management Controls renovations at multiple campuses defined in the construction documents.

Demolition work and removal of all non-used materials off-site in a legal manner is included (mechanical and electrical).

31. Drawing List

MEP

MEPD101-C	MECHANICAL/ELECTRICAL/PLUMBING DEMOLITION FLOOR PLAN

MEPD102-C	MECHANICAL/ELECTRICAL/PLUMBING DEMOLITION FLOOR PLAN
MEP101-C	MECHANICAL/ELECTRICAL/PLUMBING FLOOR PLAN
MEP102-C	MECHANICAL/ELECTRICAL/PLUMBING FLOOR PLAN
MEP801-C	MECHANICAL SCHEDULES
MEP802-C	MECHANICAL SCHEDULES
MEPD101-J	MECHANICAL/ELECTRICAL/PLUMBING DEMOLITION FLOOR PLAN
MEPD102-J	MECHANICAL/ELECTRICAL/PLUMBING DEMOLITION GYM FLOOR PLAN
MEP101-J	MECHANICAL/ELECTRICAL/PLUMBING FLOOR PLAN
MEP102-J	MECHANICAL/ELECTRICAL/PLUMBING GYM FLOOR PLAN
MEP801-J	MECHANICAL SCHEDULES
MEPD101-W	MECHANICAL/ELECTRICAL/PLUMBING DEMOLITION FLOOR PLAN
MEP101-W	MECHANICAL/ELECTRICAL/PLUMBING FLOOR PLAN
MEP801-W	MECHANICAL SCHEDULES
MEP701	MECHANICAL DETAILS, SYMBOLS, & NOTES
MEP702	MECHANICAL DETAILS
MEP703	MECHANICAL/ELECTRICAL DETAILS
MEP704	ELECTRICAL GENERAL NOTES, SYMBOLS, & DETAILS
MEP705	MECHANICAL PIPING SCHEMATICS
MEP706	MECHANICAL PIPING SCHEMATICS

Exhibit "A"
PREVAILING WAGE RATE
MOUNT PLEASANT ISD

PART 1 - GENERAL

1.1 Requirements

Pay not less than the minimum wage scale and benefits indicated on the "Minimum Wage Schedule" provided herein.

Wages listed are minimum rates only.

No claims for additional compensation will be considered by the Owner because of payments of wage rates in excess of the applicable rate contained in this contract.

1.2 Applicable Statutes

Vernon's Civil Statutes, Section 2 of Article 5159a which states as follows:

> "The Contractor shall forfeit as a penalty to the State, County, City and County, City, Town, District or other political subdivision on whose behalf the Contract is made or awarded, ten dollars ($10.00) for each laborer, workman or mechanic, for each working day, or portion thereof, such laborer, workman or mechanic is paid less than the said stipulated rates for any work done under said Contract, by him, or by any subcontractor under him, and the public body awarding the Contract shall cause to be inserted in the Contract a stipulation to this effect."

1.3 Payroll

In compliance with Article 5159a, Sections 2 and 3, and Article 5159d, Section II of the Revised Civil Statutes referenced above, the Owner reserves the following rights:

1. To receive weekly payroll records.
2. To have the Contractor provide required earning statements to employees.

1.4 Minimum Wage Rates

Pay prevailing basic wage listed, plus any applicable fringe benefits.

PREVAILING WAGE SCALE NOTICE

1. As a result of the use of Federal Funding, the provisions of the Davis-Bacon Act (40 U.S.C. 3141 et seq) are applicable. A prevailing wage determination effective as of the advertisement for bids should be considered by bidders in preparing a bid. Under the Davis-Bacon requirements, a contractor is obligated to pay at least the prevailing wage listed in the Contract Wage Determination for each laborer and mechanic entirely as cash wages or by a combination of cash wages and employer-provided bona fide fringe benefits. Prevailing wages, including fringe benefits, must be paid on all hours worked on the project site

   This determination of prevailing wages shall not be construed to prohibit the payment of more than the rates named. Under no condition shall any laborer, workman or mechanic employed on this job be paid less than the minimum wage scale.

   Contractors and subcontractors will be required to pay covered workers weekly and submit weekly certified payroll records to the Owner.

   In addition, contractors and subcontractors are required to post the applicable Davis-Bacon wage determination with the Davis-Bacon poster on the job site in a prominent and accessible place where they can be easily seen by the workers

2. In execution of this contract, the Contractor must comply with all applicable state and federal laws including, but not limited to, laws concerned with labor, equal employment opportunity, safety and minimum wage.

3. Basic Rates.

   See rates included in this section.

Apprentice Pay-All Trades and Crafts:

The minimum rate for apprentices shall be in accordance with the scale determined by an approved apprenticeship program or $1.00 per hour less than journeymen's rates, whichever is lower. An approved apprenticeship program is one approved by the U.S. Department of Labor, Bureau of Apprenticeship Training, and only apprentices enrolled in an approved program may be paid apprenticeship rates.

Base Per Diem Rate:

Hours Worked/Day Times Base Hourly Rate

Multipliers for Overtime Rates:

1. Over 40 hours per week: Base hourly rate times 1.5
2. Holidays: Base hourly rate times 1.5

DAVIS-BACON WAGE RATES (TITUS COUNTY, TEXAS)

"General Decision Number: TX20220185 01/07/2022

Superseded General Decision Number: TX20210185

State: Texas

Construction Type: Building

County: Titus County in Texas.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022, Executive Order 14026 generally applies to the contract. The contractor must pay all covered workers at least $15.00 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2022.

If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022, Executive Order 13658 generally applies to the contract. The contractor must pay all covered workers at least $11.25 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2022.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at

www.dol.gov/whd/govcontracts.

Modification Number Publication Date
0 01/07/2022

ASBE0021-002 08/01/2017

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR	$ 25.87	7.23

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* BOIL0587-003 01/01/2021

	Rates	Fringes
Boilermaker	$ 29.47	24.10

IRON0263-019 06/01/2020

	Rates	Fringes
Ironworker, reinforcing and structural	$ 25.14	7.43

LABO0154-022 05/01/2008

	Rates	Fringes
Laborers: (Mason Tender - Cement/Concrete)	$ 14.25	2.90

SUTX2009-072 04/20/2009

	Rates	Fringes
BRICKLAYER	$ 20.00	0.00
CARPENTER, Includes Acoustical Ceiling Installation, and Hardwood Floor Installation	$ 14.30	0.00
CEMENT MASON/CONCRETE FINISHER	$ 13.29	0.00
ELECTRICIAN	$ 18.06	4.87
IRONWORKER, STRUCTURAL	$ 15.48	0.00

LABORER: Common or General.....$ 9.73 0.00

LABORER: Landscape & Irrigation.....$ 8.50 0.22

LABORER: Mason Tender - Brick...$ 12.02 0.00

LABORER: Mortar Mixer.....$ 12.00 0.00

OPERATOR: Backhoe/Excavator/Trackhoe.....$ 11.00 0.00

OPERATOR: Bulldozer.....$ 13.00 0.31

OPERATOR: Crane.....$ 21.33 0.00

OPERATOR: Forklift.....$ 14.58 0.00

OPERATOR: Loader (Front End)....$ 10.54 0.00

PAINTER: Brush, Roller and Spray.....$ 13.50 0.00

PLUMBER.....$ 20.38 4.74

ROOFER.....$ 13.64 1.80

SHEET METAL WORKER.....$ 17.00 0.00

TILE SETTER.....$ 15.00 0.00

TRUCK DRIVER.....$ 12.52 0.00

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including

preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

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

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union, which prevailed in the survey for this classification, which in this example would be Plumbers 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Division National Office Branch of Wage Surveys. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

PROPOSER/VENDOR CERTIFICATION FORMS

REQUIRED CONTRACT PROVISIONS FOR NON-FEDERAL ENTITY CONTRACTS UNDER FEDERAL AWARDS -APPENDIX II TO 2 CFR PART 200

The following provisions are required and apply when federal funds are expended by Mount Pleasant ISD for any contract resulting from this procurement process.

(A) Contracts for more than the simplified acquisition threshold currently set at $150,000, which is the inflation adjusted amount determined by the Civilian Agency Acquisition Council and the Defense Acquisition Regulations Council (Councils) as authorized by 41 U.S.C. 1908, must address administrative, contractual, or legal remedies in instances where contractors violate or breach contract terms, and provide for such sanctions and penalties as appropriate.

Pursuant to Federal Rule (A) above, when federal funds are expended, Mount Pleasant ISD reserves all rights and privileges under the applicable laws and regulations with respect to this procurement in the event of breach of contract by either party.

Does vendor agree? YES _____ (If yes, insert initials of Authorized Representative of vendor.)

(B) Termination for cause and for convenience by the grantee or sub grantee including the manner by which it will be effected and the basis for settlement. (All contracts in excess of $10,000)

Pursuant to Federal Rule (B) above, when federal funds are expended, Mount Pleasant ISD reserves the right to immediately terminate any agreement in excess of SI 0,000 resulting from this procurement process in the event of a breach or default of the agreement by Vendor, in the event vendor fails to: (I) meet schedules, deadlines, and/or delivery dates within the time specified in the procurement solicitation, contract, and/or a purchase order; (2) make any payments owed; or (3) otherwise perform in accordance with the contract and/or the procurement solicitation. Mount Pleasant ISD also reserves the right to terminate the contract immediately, with written notice to vendor, for convenience, i f Mount Pleasant ISO believes, in its sole discretion that it is in the best interest of Mount Pleasant ISD to do so. The vendor will be compensated for work performed and accepted and goods accepted by Mount Pleasant ISD as of the termination date if the contract is terminated for convenience of Mount Pleasant ISD. Any award under this procurement process is not exclusive and Mount Pleasant ISD reserves the right to purchase goods and services from other vendors when it is in the best interest of Mount Pleasant ISD to do so.

Does vendor agree to abide by the above?

YES _____ (If yes, insert initials of Authorized Representative of vendor.)

(C) Equal Employment Opportunity. Except as otherwise provided under 41 CFR Part 60, all contracts that meet the definition of "federally assisted construction contract" in 41 CFR Part 60-1.3 must include the equal opportunity clause provided under 41 CFR 60-1.4(b), in accordance with Executive Order 11246, "Equal Employment Opportunity" (30 FR 12319, 12935, 3 CFR Part, 1964-1965 Comp., p. 339), as amended by Executive Order 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," and implementing regulations at 41 CFR part 60, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor."

Pursuant to Federal Rule (C) above, when federal funds are expended by Mount Pleasant ISD on any federally assisted construction contract, the equal opportunity clause is incorporated by reference herein.

Does vendor agree to abide by the above?

YES _____ (If yes, insert initials of Authorized Representative of vendor.)

(D) Davis-Bacon Act, as amended (40 U.S.C. 3141-3148) . When required by Federal program legislation, all prime construction contracts in excess of $2,000 awarded by non-Federal entities must include a provision for compliance with the Davis-Bacon Act (40 U.S.C.3141-3144, and 3146-3148) as supplemented by Department of Labor regulations (29 CFR Part 5, "Labor Standards Provisions Applicable to Contracts Covering Federally Financed and Assisted Construction"). In accordance with the statute, contractors must be required to pay wages to laborers and mechanics at a rate not less than the prevailing wages specified in a wage determination made by the Secretary of Labor. In addition, contractors must be required to pay wages not less than once a week. The non-Federal entity must place a copy of the current prevailing wage determination issued by the Department of Labor in each solicitation. The decision to award a contract or subcontract must be conditioned upon the acceptance of the wage determination. The non- Federal entity must report all suspected or reported violations to the Federal awarding agency. The contracts must also include a provision for compliance with the Copeland "Anti-Kickback" Act (40 U.S.C. 3145), as supplemented by Department of Labor regulations (29 CFR Part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States"). The Act provides that each contractor or sub recipient must be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which he or she is otherwise entitled. The non-Federal entity must report all suspected or reported violations to the Federal awarding agency.

Pursuant to Federal Rule (D) above, when federal funds are expended by Mount Pleasant ISD, during the term of an award for all contracts and sub grants for construction or repair, the vendor will be in compliance with all applicable Davis-Bacon Act provisions.

Does vendor agree? YES __ (If yes, insert initials of Authorized Representative of vendor.)

(E) Contract Work Hours and Safety Standards Act (40 U.S.C. 3701-3708). Where applicable, all contracts awarded by the non-Federal entity in excess of $100,000 that involve the employment of mechanics or laborers must include a provision for compliance with 40 U.S.C. 3702 and 3704, as supplemented by Department of Labor regulations (29 CFR Part 5). Under 40 U.S.C. 3702 of the Act, each contractor must be required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than one and a half times the basic rate of pay for all hours worked in excess of 40 hours in the work week. The requirements of 40 U.S.C. 3704 are applicable to construction work and provide that no laborer or mechanic must be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

Pursuant to Federal Rule (E) above, when federal funds are expended by Mount Pleasant ISD, the vendor certifies that during the term of an award for all contracts by Mount Pleasant ISD resulting from this procurement process, the vendor will be in compliance with all applicable provisions of the Contract Work Hours and Safety Standards Act.

Does vendor agree? YES (If yes, insert initials of Authorized Representative of vendor.)

(F) Rights to Inventions Made Under a Contract or Agreement. If the Federal award meets the definition of "funding agreement" under 37 CFR §401.2 (a) and the recipient or sub recipient wishes to enter into a contract with a small business firm or nonprofit organization regarding the substitution of parties, assignment or performance of experimental, developmental, or research work under that "funding agreement ," the recipient or sub recipient must comply with the requirements of 37 CFR Part 401, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," and any implementing regulations issued by the awarding agency.

Pursuant to Federal Rule (F) above, when federal funds are expended by Mount Pleasant ISD, the vendor certifies that during the term of an award for all contracts by Mount Pleasant ISD resulting from this procurement process, the vendor agrees to comply with all applicable requirements as referenced in Federal Rule (F) above.

Does vendor agree? YES(If yes, insert initials of Authorized Representative of vendor.)

(G) Clean Air Act (42 U.5.C.7401-7671q.) and the Federal Water Pollution Control Act (33 U.5.C. 1251-1387), as amended-Contracts and sub grants of amounts in excess of $150,000 must contain a provision that requires the non-Federal award to agree to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.5.C.7401-7671q) and the Federal Water Pollution Control Act as amended (33 U.5.C. 1251- 1387).Violations must be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA).

Pursuant to Federal Rule (G) above, when federal funds are expended by Mount Pleasant ISD, the vendor certifies that during the term of an award for all contracts by Mount Pleasant ISD resulting from this procurement process, the vendor agrees to comply with all applicable requirements as referenced in Federal Rule (G) above.

Does vendor agree? YES(If yes, insert the initials of Authorized Representative of vendor.)

(H) Debarment and Suspension (Executive Orders 12549 and 12689)-A contract award (see 2 CFR 180.220) must not be made to parties listed on the government wide exclusions in the System for Award Management (SAM), in accordance with the OMB guidelines at 2 CFR 180 that implement Executive Orders 12549 (3 CFR part 1986 Comp., p. 189) and 12689 (3 CFR part 1989 Comp., p. 235), "Debarment and Suspension." SAM Exclusions contains the names of parties debarred, suspended, or otherwise excluded by agencies, as well as parties declared ineligible under statutory or regulatory authority other than Executive Order 12549.

Pursuant to Federal Rule (H) above, when federal funds are expended by Mount Pleasant ISD, the vendor certifies that during the term of an award for all contracts by Mount Pleasant ISD resulting from this procurement process, the vendor certifies that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation by any federal department or agency.

Does vendor agree? YES _____ (If yes, insert the initials of Authorized Representative of vendor.)

(I) Byrd Anti-Lobbying Amendment (31 U.S.C. 1352)-Contractors that apply or bid for an award exceeding $100,000 must file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U .S.C. 1352. Each tier

must also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the non-Federal award.

Pursuant to Federal Rule (I) above, when federal funds are expended Mount Pleasant ISD, the vendor certifies that during the term and after the awarded term of an award for all contracts by Mount Pleasant ISD resulting from this procurement process, the vendor certifies that it is in compliance with all applicable provisions of the Byrd Anti-Lobbying Amendment (31 U.S.C. 1352). The undersigned further certifies that:

(1) No Federal appropriated funds have been paid or will be paid for on behalf of the undersigned , to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of congress, or an employee of a Member of Congress in connection with the awarding of a Federal contract, the making of a Federal grant, the making of a Federal loan, the entering into a cooperative agreement, and the extension, continuation, renewal, amendment, or modification of a Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of congress, or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying", in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all covered sub-awards exceeding $100,000 in Federal funds at all appropriate tiers and that all sub-recipients shall certify and disclose accordingly.

Does vendor agree? YES___(If yes, insert the initials of Authorized Representative of vendor.)

RECORD RETENTION REQUIREMENTS FOR CONTRACTS PAID FOR WITH FEDERAL FUNDS - 2 CFR §200.333

When federal funds are expended by Mount Pleasant ISD for any contract resulting from this procurement process, the vendor certifies that it will comply with the record retention requirements detailed in 2 CFR § 200.333. The vendor further certifies that vendor will retain all records as required by 2 CFR § 200.333 for a period of three years after grantees or sub-grantees submit final expenditure reports or quarterly or annual financial reports, as applicable, and all other pending matters are closed.

Does vendor agree? YES_____(If yes, insert the initials of Authorized Representative of vendor.)

CERTIFICATION OF COMPLIANCE WITH THE ENERGY POLICY AND CONSERVATION ACT

When federal funds are expended by Mount Pleasant ISD for any contract resulting from this procurement process, the vendor certifies that the vendor will be in compliance with mandatory standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (42 U.S.C.

6321, et seq.; 49 C.F.R. Part 18).

Does vendor agree? YES _____ (If yes, insert the initials of Authorized Representative of vendor.)

CERTIFICATION OF COMPLIANCE WITH BUY AMERICA PROVISIONS

Vendor certifies that vendor is in compliance with all applicable provisions of the Buy America Act. Purchases made in accordance with the Buy America Act must still follow the applicable procurement rules calling for free and open competition.

Does vendor agree? YES___(If yes, insert the initials of Authorized Representative of vendor.)

CERTIFICATION OF NON-COLLUSION STATEMENT

Vendor certifies under penalty of perjury that its response to this procurement solicitation is in all respects bona fide, fair, and made without collusion or fraud with any person, joint venture, partnership, corporation or other business or legal entity.

Does vendor agree? YES___(If yes, insert the initials of Authorized Representative of vendor.)

Vendor agrees to comply with all federal, state, and local laws, rules, regulations and ordinances, as applicable. It is further acknowledged that vendor certifies compliance with all provisions, laws, acts, regulations, etc. as specifically noted above under Proposer/Vendor Certification Forms.

Vendor's Name/Company Name: _____

Address, City, State and Zip Code: _____

Phone Number: _____

Printed Name and Title of Authorized Representative: _____

Email Address: _____

Signature of Authorized Representative _____

Mount Pleasant Independent School District
Purchasing Department
Administration Building
2230 N. Edwards Ave
Mount Pleasant, TX 75455
Attention: Purchasing Director

PROPOSAL FORM/BID FORM
2022 District Wide ESSER
HVAC Renovations to Multiple Campuses
Mount Pleasant Independent School District
EMA Project No. 1 001 0847 001

I have received plans, and specifications for the project listed above as prepared by Estes, McClure, And Associates, Inc. I have also received Addenda Nos. _____ and have included their provisions in my proposal. I have examined these documents, all of the existing site, and plans/specifications and submit the following proposal. In submitting the proposal, I agree:

1. To hold my bid open for 60 days after bid receiving date.

2. To accept the provisions of the Instructions to Bidders regarding disposition of bid security.

3. To enter into and execute a contract, if awarded on the basis of this bid.

4. To accomplish the work in accordance with the Contract Documents.

5. Work can begin on **May 27th, 2022**. Coordinate with the on-going school programs. I will substantially complete all HVAC work by the following schedule and complete all work by the following dates.

Substantial Completion	**Final Completion**
July 29th, 2022	August 05th, 2022

6. To deliver within five days of receipt of contract all required submittals, list of all suppliers and a schedule of work.

7. I will perform all work as described within these Contract Documents for the prices presented on the following pages, including this page. Bids shall be entered in appropriate spaces of this Proposal Form. I understand that Mount Pleasant ISD reserves the right to accept or reject any and all bids and has the right to accept or reject parts of the bid package.

8. **Mount Pleasant Junior High School**

   a) I will provide complete turn-key work (including all related work) that includes, but is not limited to HVAC renovations for the total lump sum price of _____

   _____($_____).

9. **Mount Pleasant Junior High School – Alternate No. 1**

   b) I will provide complete turn-key work (including all related work) that includes, but is not limited to new EMCS replacement for the total lump sum price of _____

   _____($_____).

P.E. Wallace Middle School

c) I will provide complete turn-key work (including all related work) that includes, but is not limited to HVAC renovations for the total lump sum price of _____

_____($_____).

10. **P.E. Wallace Middle School – Alternate No. 2**

d) I will provide complete turn-key work (including all related work) that includes, but is not limited to new EMCS replacement for the total lump sum price of _____

_____($_____).

Frances Corprew Elementary School

e) I will provide complete turn-key work (including all related work) that includes, but is not limited to HVAC renovations for the total lump sum price of _____

_____($_____).

11. **Frances Corprew Elementary – Alternate No. 3**

f) I will provide complete turn-key work (including all related work) that includes, but is not limited to new EMCS replacement for the total lump sum price of _____

_____($_____).

12. **Frances Corprew Elementary – Alternate No. 4**

g) I will provide complete turn-key work (including all related work) that includes, but is not limited to all work in both central plants for the total lump sum price of _____

_____($_____).

Junior High School – Wallace Middle School - Corprew Elementary (Base Bids)

h) I will provide complete turn-key work (including all related work) that includes, but is not limited to HVAC and EMCS renovations for the total lump sum price of _____

_____($_____).

The above lump sum for includes an **allowance of $200,000.00 for construction contingency** for the combined three campuses.

13. Proposers shall submit a detailed schedule and staffing plan for the scope of work defined in the construction documents so as to be completed on August 5, 2022

14. I understand a Performance and Payment Bond is required and a Bid Bond is required.

15. I also certify that I have visited all of the existing buildings where work is to be performed and understand the site conditions and work required. I will provide all work turn-key. Contractor shall provide a person whose primary job is to supervise and coordinate this work.

16. The cost of all bonds, insurance and guarantees are included in my bid prices.

17. I understand liquidated damages apply from date of substantial completion and from date of completion until all work is complete for each scheduled project and acceptable by Engineer and Owner (See General Conditions and Specification Section 00 80 00 - Supplementary Conditions, Article 17 including but not limited to Paragraph 17.9.1).

18. Enclosed with this bid is a complete list of subcontractors that I will use on this project.

19. I am enclosing with the bid, the qualification form as specified in 00 32 00-1.

20. By submitting a bid, each bidder agrees to waive any claim it has or may have against the Owner, the Engineer, and their respective employees arising out of or in connection with the administration, evaluation, or recommendation of any bid; waiver of any requirements under the Bid Documents, or the Contract Documents, acceptance or rejection of any bids; and award of the Contract.

21. Representations: by execution and submission of this Bid, the Bidder hereby represents and warrants to Owner as follows:

The Bidder has read and understands the Bid Documents and the contract documents and this Bid is made in accordance with the Bid Documents.

Date: _____ BIDDER: _____
Company Name

_____
Signature Name Typed

_____
Signature in Ink

TITLE: _____

ADDRESS: _____

PHONE: _____

FAX: _____

CERTIFICATION BY CORPORATE BIDDER
2022 District Wide ESSER HVAC Renovations
To Multiple Campuses
Mount Pleasant Independent School District

IF BIDDER IS A CORPORATION, THE FOLLOWING CERTIFICATE SHOULD BE EXECUTED AND INCLUDED AS PART OF PROPOSAL FORM/BID FORM.

I, _____, certify that I am the _____, Secretary of the Corporation named as Bidder hereinabove; that _____ who signed the foregoing proposal on behalf of the bidder was then _____ of the said corporation; that said proposal was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

_____
CORPORATE SEAL

_____
SIGNATURE

_____
DATE

BIDDER'S QUALIFICATION FORM
2022 District Wide ESSER HVAC Renovations
Mount Pleasant Independent School District

American Institute of Architects Document A305 "Contractor's Qualification Statement", current edition, is hereby made a part of the Contract Documents by reference. A complete copy of this document may be examined in the office of the Engineer, EMA Engineering & Consulting 328 South Broadway Ave. Tyler, Texas 75702, or obtained from the American Institute of Architects, 1735 New York Ave., N.W., Washington, D.C. 20006.

Bidders shall submit with the proposal a notarized Contractor's Qualification Statement on AIA Document A305 regarding the qualifications of the Bidder. Provide seven (7) references of specific related school work. For each reference provide project name, Owner's contact (name/phone/address), and Engineer (name/phone/address). Section 16.0 pertaining to the firm's audited financial statement may be withheld until such time it is specifically requested in writing by the Engineer or Owner.

Bidders shall obtain and submit, within 24 hours of the receipt of a written request from the Engineer, notarized Contractor's Qualification Statements on AIA Document A305 regarding the qualifications of the major subcontractors proposed for use in the Work. Section 16.0 pertaining to the firm's audited financial statement may be withheld until such time it is specifically requested in writing by the Engineer or Owner.

LIST OF SUBCONTRACTORS/SUPPLIERS
2022 District Wide ESSER HVAC Renovations
Mount Pleasant Independent School District

THIS FORM SHALL BE COMPLETED BY THE GENERAL CONTRACTOR AND SUBMITTED IN SEPARATE ENVELOPE WITH PROPOSAL. A complete list of proposed subcontractors, material suppliers and proprietary items will be required from the successful Bidder, not later than fifteen (15) days from the contract date. The bid submittals required on bid form shall be provided in separate package at time of bid.

TO: MOUNT PLEASANT INDEPENDENT SCHOOL DISTRICT
2230 North Edwards Ave
Mount Pleasant, Texas 75455
Attention: Purchasing Director

The undersigned submits the following names of subcontractors to be used in performing the contract. Where blanks are provided for the listing of Contractor and subcontractors, Bidders are advised that each blank shall be filled in with name of a legitimate Contractor or subcontractor now engaged in an established business in that category. Failure to do so may be cause for rejection of proposal.

Subcontractors

Mechanical: (Bidder) _____

Electrical: _____

HVAC Supplier: _____

Test and Balance: _____

EMCS: _____

Date: _____ BIDDER: _____
(Company Name)

_____
(Signature)

_____
(Address)

By: _____

Title: _____

Mechanical Contractor shall be Bidder.

FELONY CONVICTION NOTIFICATION

Statutory citation covering notification of criminal history of contractor is found in the Texas Education Code #44.034. Following is an example of a felony conviction notice:

State of Texas Legislative Senate Bill No. 1, Section 44.034, Notification of Criminal History, Subsection (a), states "a person or business entity that enters into a contract with a school district must give advance notice to the district if the person or an owner or operator of the business entity has been convicted of a felony. The notice must include a general description of the conduct resulting in the conviction of a felony."

Subsection (b) states "a school district may terminate a contract with a person or business entity if the district determines that the person or business entity failed to give notice as required by Subsection (a) or misrepresented the conduct resulting in the conviction. The district must compensate the person or business entity for services performed before the termination of the contract."

THIS NOTICE IS NOT REQUIRED OF A PUBLICLY-HELD CORPORATION

I, the undersigned agent for the firm named below, certify that the information concerning notification of felony convictions has been reviewed by me and the following information furnished is true to the best of my knowledge.

COMPANY NAME: _____

AUTHORIZED COMPANY OFFICIAL'S NAME (PRINTED): _____

A. My firm is a publicly-held corporation, therefore, this reporting requirement is not applicable.

Signature of Company Official: _____

B. My firm is not owned nor operated by anyone who has been convicted of a felony:

Signature of Company Official: _____

C. My firm is owned or operated by the following individual(s) who has/have been convicted of a felony:

Name of Felon(s): _____

Details of Conviction(s): _____

_____

Signature of Company Official: _____

FINGER PRINTING PROVISIONS
2022 District Wide ESSER HVAC Renovations
Mount Pleasant Independent School District

All Contractors and Sub-Contractors working on building projects for Mount Pleasant ISD will be required to submit to the Coordinator of Human Resources proof that their firm has met state fingerprinting requirements for employees hired by their firm after January 1, 2008. This requirement is for employees of contractors and sub-contractors working on any MPISD construction site, whether or not the site is currently being used as a campus since most workers will be working on multiple sites.

Information for establishing a fingerprinting account with the Texas Department of Public Safety (Instructions to School District Contractors Regarding Criminal History Background Searches Under Senate Bill 9) will be available through Mount Pleasant ISD Human Resources.

Employee Fingerprinting must be completed prior to the employee working on any MPISD construction site. It is the contractor's responsibility to make sure that all employees meet state criminal history guidelines. Mount Pleasant ISD reserves the right to prohibit any employee of a contractor or sub-contractor from working on a MPISD site if that employee's criminal history record does not meet school district standards.

No Employees are allowed to work onsite until there is confirmation from Mount Pleasant ISD that all requirements are met. Any employees without the necessary confirmation will be removed from the site according to policy. MPISD Human Resources will then contact your company to let you know who and who is not allowed to work onsite.

AGREEMENT FORM
2022 District Wide ESSER HVAC Renovations
Mount Pleasant Independent School District

Contract shall be prepared on "Standard Form of Agreement Between Owner and Contractor". On the Basis of A Stipulated Price (refer to owner for sample contract).

PERFORMANCE BOND FORM
2022 District Wide ESSER HVAC Renovations
Mount Pleasant Independent School District

Contractor(s) and subcontractors (as specified) shall furnish a Performance Bond for 100% of the work. The Performance Bond(s) shall be prepared on a form acceptable to the Owner and must identify compliance with the provisions of Article 5160 of the Revised Civil Statutes of Texas and state that all liabilities of the bond(s) shall be determined in accordance with the provisions of said Article. The Surety must be authorized to do business under a Certificate of Authority issued by the State of Texas and hold Certificates of Authority as an acceptable Surety on the Current Department of the Treasury listing as found in the Federal Register. The bond shall be a U.S.A. company and located in U.S.A.

Performance and Payment Bond required from General Contractor (Mechanical Contractor).

Bonds shall be received and approved by Owner before a Purchase Order will be issued.

The following attachment consisting of five (5) pages provides additional Owner requirements and required form.

LABOR AND MATERIAL PAYMENT BOND
2022 District Wide ESSER HVAC Renovations
Mount Pleasant Independent School District

Contractor(s) and subcontractors (as specified) shall furnish a Labor and Material Bond for 100% of the value of the work. The Performance Bond(s) shall be prepared on a form acceptable to the Owner and must identify compliance with the provisions of Article 5160 of the Revised Civil Statutes of Texas and state that all liabilities of the bond(s) shall be determined in accordance with the provisions of said Article. The Surety must be authorized to do business under a Certificate of Authority issued by the State of Texas and hold Certificates of Authority as an acceptable Surety on the Current Department of the Treasury listing as found in the Federal Register. The bond shall be a U.S.A. company and located in the U.S.A.

Performance and Payment Bond required from General Contractor (Mechanical Contractor).

Bonds shall be received and approved by Owner before a Purchase Order will be issued.

The following page provides additional Owner requirements and required form.

GENERAL CONDITIONS

1. GENERAL:
   A. National Society of Professional Engineers, Document EDCDC No. 1910-8., "General Conditions of the Construction Contract", 1996 Edition, is hereby made a part of this Contract and shall apply to all Contractors and Subcontractors.

   B. Copies of the above mentioned document as referred to herein, are on file and may be referred to at the Engineer's office at 328 Broadway Ave, Tyler, Texas, or may be purchased from the National Society of Professional Engineers, 1420 King Street, Alexandria, Virginia 22314, phone 703-684-4811.

SUPPLEMENTARY CONDITIONS

1. SUPPLEMENTS.

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract (No. 1910-8, 1996 Edition) and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect.

The terms used in these Supplementary Conditions will have the meanings indicated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings indicated below, which are applicable to both the singular and plural thereof.

2. REFERENCE TO DIVISION 1:

Where provisions of General Conditions related to project administration or work-related requirements of the Contract, those paragraphs are supplemented by Sections in Division 1, "General Requirements" of the Specifications.

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01.A.28 Notice of Award:

Amend the sentence to read as follows:

The written notice by OWNER or ENGINEER to the apparent successful bidder stating that upon timely compliance by the apparent successful bidder with the condition's precedent listed therein, OWNER will sign and deliver the Agreement.

1.01.A.28 Notice to Proceed:

Amend the sentence to read as follows:

A written notice given by OWNER or ENGINEER to CONTRACTOR fixing the date on which the Contract Times will commence to run and on which CONTRACTOR shall start to perform the Work under the Contract Documents.

ARTICLE 2 - PRELIMINARY MATTERS

2.02. Copies of Documents: N/A

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE.

3.01. Add the following language at the end of the first sentence:

No contract is binding upon the OWNER until it has been executed by the OWNER and delivered to the CONTRACTOR.

Add the following new paragraph at the end of Article 3:

3.06. Inter-Relation Of Documents:

A. The inter-relation of the specifications, the drawings and the schedules is as follows: The specifications determine the nature and setting of the several materials, the drawings establish the quantities, dimensions and details, and the schedules give the locations. Anything mentioned in the specifications and not shown on the drawings or schedules, or shown on the drawings or schedules and not mentioned in the specifications, shall be of like effect as if shown or mentioned in both. Should the drawings disagree in themselves or with the specifications, the better quality or greater quantity of work or materials shall be estimated upon, and unless otherwise ordered by the ENGINEER in writing, shall be performed or furnished. In case the specifications should not fully agree with the schedules, the former shall govern. Figures given on drawings govern scale measurements and large scale details govern small scale drawings. In case of discrepancy in the figures, in the drawings, in the schedules or in the specifications, the matter shall be promptly submitted to the ENGINEER who will promptly make a determination, after advice and consent of the OWNER, in writing.

ARTICLE 5 - BONDS AND INSURANCE

SEE ARTICLE 17 THIS SPECIFICATION FOR ADDITIONAL OWNER INSURANCE REQUIREMENTS. FOR ANY DIFFERENCE BETWEEN ARTICLE 5 INSURANCE REQUIREMENTS AND ADDITIONAL OWNER REQUIREMENTS IN ARTICLE 17, PROVIDE THE MOST STRINGENT AND MOST COVERAGE.

THE IMMUNITY OF THE OWNER SHALL NOT BE DEFENSE FROM THE INSURANCE CARRIER.

INSURANCE SPECIFICATIONS
Prior to the execution of the Contract Agreement, Contractor/Construction Manager will submit a Certificate of Insurance showing existing insurance coverage. The Certificate of Insurance shall serve as evidence of insurance that the Construction Manager maintains the Minimum Limits of Liability shown below.

TERMS OF INSURANCE SPECIFICATIONS:
The Contractor / Construction Manager / Subcontractors shall maintain the limits and terms shown below for a period of no less than two (2) years after the final payment to the Contractor / Construction Manager / Subcontractor.

NONCOMPLIANCE WITH INSURANCE SPECIFICATIONS:
This Contract may be terminated by the Owner in the event the Contractor / Construction Manager fails to maintain any insurance coverage specified.

MINIMUM LIMITS OF LIABILITY.
The Contractor / Construction Manager /Subcontractors shall maintain at least the following limits of liability. The coverage should be issued with an insurance company that is rated by A.M. Best. The rating should not be less than A- VII.

The Contractor I Construction Manager shall cause all its' Subcontractors to maintain similar insurance. Subcontractor must maintain limits of insurance for the specified term in Article 11.1.2 of the AIA Document A201 - 2007. Certificates of Insurance should be provided by the Subcontractor to the Contractor / Construction Manager prior to the commencement of work on the project.

All policies for the Contractor / Construction Manager / Subcontractors shall contain a provision that the coverage afforded shall not be canceled or not renewed, nor restrictive modifications or changes added until at least (30) days prior written notice has been given to the Owner.

Commercial General Liability

Liability Limit and Coverage of No Less Than:

General Aggregate	$ 2,000,000
Products / Completed Operations Aggregate	$ 2,000,000
Personal & Advertising Injury	$ 1 000,000
Each Occurrence	$ 1,000,000
Fire Legal Liability	$ 100,000
Medical Payments	$ 5,000

•Occurrence Form

• Contractual Liability covering the above indemnity agreement.

• Products & Completed Operations Liability must extend to work performed under this contract.

• Coverage for explosion, collapse, or underground damage arising out of the work performed under this contract.

• Additional Insured Endorsement for both "on going" and "completed operations" shall apply in favor of Owner, Architect, and Architect's consultants.

• Waiver of Subrogation Endorsement shall apply in favor of Owner, Architect, and Architect's consultants.

• 30-day Notice of Cancellation shall apply in favor of Owner (applicable to Nonpayment of Premium also)

• The insurance shall be Primary and Noncontributory from other such insurance available to the Owner, Architect, and Architect's consultants.

• Limits must apply per project.

Business Automobile Liability

Liability Limit and Coverage of No Less Than:

Combined Single Limit	$ 1,000,000
Per Occurrence	
Applies to Bodily Injury & Property Damage	

• Coverage extends for use of all owned, non-owned, and hired vehicles.

• Additional Insured Endorsement shall apply in favor of Owner, Engineer, and Engineer's consultants.

• Waiver of Subrogation Endorsement shall apply in favor of Owner, Engineer, and Engineer's consultants.

• 30-day Notice of Cancellation in favor of Owner (applicable to Non-Payment of Premium also)

Workers' Compensation

Workers' Compensation must apply in accordance with the laws of all jurisdictions that may apply to the work being performed and including Employers Liability.

Employers Liability Limit of No Less Than:	
Bodily Injury By Accident	$1,000,000 Each Accident
Bodily Injury By Disease	$1,000,000 Policy Limit
Bodily Injury By Disease	$1,000,000 Each Employee

Waiver of Subrogation Endorsement shall apply in favor of Owner, Engineer, and Engineer's consultants.

• 30-day Notice of Cancellation in favor of Owner (applicable to Non-Payment of Premium also)

Excess Umbrella (Applicable to Construction Manager / Contractor)

Liability Limit and Coverage of No Less Than:	
Per Occurrence	$5,000,000
Policy Aggregate	$5,000,000

Policy must extend over the coverage and terms shown above for the following:
Commercial General Liability
Business Automobile Liability
Employers Liability

Excess Umbrella (Applicable to Subcontractor)

Liability Limit and Coverage of No Less Than:	
Per Occurrence	$1,000,000
Policy Aggregate	$1,000,000

Policy must extend over the coverage and terms shown above for the following:
Commercial General Liability
Business Automobile Liability
Employers Liability

Contractors Pollution Liability (Applicable to Contractor / Construction Manager)

Liability Limit and Coverage of No Less Than:	
Per Occurrence	$1,000,000
Policy Aggregate	$1,000,000

This policy may be written on a "Claims-Made or Occurrence" Basis.

ARTICLE 6: CONTRACTORS RESPONSIBILITIES & OTHER PROVISIONS

Labor; Working Hours:

Delete 6.02.B in its entirety.

Insert the following at the end of Article 6.

6.21. Wage Rates and Statutory Penalties:

The OWNER has ascertained the General Prevailing Rate of Per Diem Wages for each credit or type of workman or mechanic and has specified this rate in the call for bids and has also ascertained the prevailing rate for legal holiday and overtime work. These rates set out in Exhibit "A" in the Instruction to Bidders, form part of the Contract Documents, and are incorporated herein by reference in their entirety. The CONTRACTOR and any Subcontractor under him shall pay no less than the aforesaid rates. Nothing herein shall prevent the payment of amounts greater than such rates. The provisions of Article 5159a of the Texas Revised Civil Statutes Annotated, as presently in effect or hereafter amended, are incorporated herein by reference in their entirety. The CONTRACTOR acknowledges the penalty provisions therein, and the CONTRACTOR for himself and each Subcontractor under him shall keep an accurate record showing the name, social security number, occupation by specific trade classification and level as set out in the General Prevailing Rate of Per Diem Wages, hours worked, and actual wages and other benefits paid to each laborer, workman, and mechanic and other person covered by said Article 5159a, and shall provide the OWNER with Certification thereof no less often than monthly during the performance of the Work.

6.22. Equal Opportunity In Employment:

6.22.A. The CONTRACTOR and all Subcontractors under him shall not discriminate against any employee or applicant for employment because of race, religion, color, sex, age or national origin. The CONTRACTOR shall take affirmative action to insure that applicants are employed, and that employees are treated during employment without regard to their race, religion, color, sex, age, or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation and selection for training, including apprenticeship. The CONTRACTOR agrees to post in conspicuous places, available to employees and applicants for employment, notice setting forth the policies of non-discrimination.

6.22.B. The CONTRACTOR and all Subcontractors shall, in all solicitation or advertisements for employees placed by them or on their behalf, state all qualified applicants will receive consideration for employment without regard to race, religion, color, sex, age, or national origin.

6.22.C. The CONTRACTOR and all Subcontractors agree that the provisions of Paragraph 6.3.2.1. and Paragraph 6.3.2.2. shall be binding on each Subcontractor or vendor; the CONTRACTOR further agrees to permit access to his books, records, and accounts by the OWNER or his agent for the purpose of investigations to ascertain compliance with such agreement.

6.23. Citizenship Or Residency (New):

The CONTRACTOR and all Subcontractors under him who recruit or hire an individual for employment under his contract shall require each individual to attest that he is a citizen or national of the United States or an alien lawfully admitted for permanent residence. Such attestation shall

be on an employment eligibility verification form (Form I-9, provided by the U.S. Department of Justice, Immigration and Naturalization Service, attached herein) to be completed and signed by both the employee and the CONTRACTOR and all Subcontractors and their employees on the form provided.

6.24. Manufacturers and Installing Subcontractors (New):

The ENGINEER will promptly reply in writing to the CONTRACTOR stating whether the OWNER or the ENGINEER, after due investigation, has reasonable objection to any such proposal. If adequate data on any proposed manufacturer or installer is not available, the ENGINEER may state that action will be deferred until the CONTRACTOR provides further data. Failure of the OWNER or ENGINEER to reply promptly shall constitute notice of no reasonable objection. Failure to object to a manufacturer shall not constitute a waiver of any of the requirements of the Contract Documents, and all products furnished by listed manufacturer must conform to such requirements.

Taxes

6.10. This Paragraph is deleted in its entirety. The following is substituted:

6.10. The materials to be incorporated into this project will be exempt from the Limited Sales, Excise and Use Tax imposed by the Act (TEX-TAX GEN. ANN Art. 20.01 et. seq.). An Exemption Certificate will be issued by the OWNER to the successful bidder and the Contract between the OWNER and the CONTRACTOR will contain separate amounts specifically stated for the following:

Labor, overhead and profit Materials to be incorporated into the construction project.

The CONTRACTOR shall ascertain the amounts applicable to the above classifications which will be incorporated into the Contract. Reference is hereby made to the Limited Sales, Excise and Use Texas Ruling No. 9, amended April 3, 1962, in which the Comptroller of Public Accounts of the State of Texas sets forth the rights and obligations of the parties to a contract of this type. (Applicable to repairmen and CONTRACTORS).

6.12 Record Documents:

Add the following sentences to 6.12:

The CONTRACTOR shall keep on the site of the Work a copy of the Contract Documents and shall at all times give the OWNER or his representative and agents access thereto. Further, the CONTRACTOR shall maintain a record set of drawings which reflect the "As-Constructed" conditions and representations of the Work performed, whether it be directed by Addendum, Change Order or otherwise. All records prescribed herein shall be made available for reference and examination by the OWNER and his representatives and agents. The CONTRACTOR shall update the "As-Constructed" drawings a minimum of once monthly prior to submission of periodic partial pay estimates. Failure to maintain such records shall constitute cause for denial of a progress payment otherwise due. Upon completion of all the Work and at the time of final acceptance by the OWNER, the CONTRACTOR shall furnish a complete set of mark-up "As Constructed" drawings to the OWNER.

6.20 Indemnification:

Add the following to Article 6, paragraph 6.20 - Indemnification.

The CONTRACTOR will be required to provide insurance as set forth in the contract between the OWNER and the CONTRACTOR and as further set forth under Supplementary Conditions, Article 5, Insurance. However, the required indemnification as set forth herein will be effective without regard to the availability of insurance to the CONTRACTOR. The CONTRACTOR shall carry Contractual Liability (Blanket Broad Form) with limits equal to general liability limits. The CONTRACTOR shall carry Broad Form Property Damage with limits equal to general liability limits. The liability of the CONTRACTOR is not limited to the availability of insurance nor to limits that are specified therein. This indemnification is in addition to and not in lieu of, the general conditions, the supplementary conditions and amendments as set forth in the general contract. CONTRACTOR shall indemnify and hold harmless OWNER, OWNER'S employees, and consultants to OWNER.

Concerning Subcontractors, Suppliers And Others:

Delete 6.06.A and 6.06.B in their entirety and substitute the following:

6.06.A. Unless otherwise required by the Contract documents, including the Bidding Documents, the Bidder awarded the Contract, as soon as practicable after the receipt of bids, and before the execution of the Contract, shall submit to the OWNER and the ENGINEER in writing the names of all manufacturers, materials or equipment, which are proposed or used in the construction of the Project. No Subcontractor or such person or entity shall be employed by the CONTRACTOR should the ENGINEER or OWNER have reasonable objection. The CONTRACTOR will not be required to employ any Subcontractor, or such person or entity against whom any Subcontractor, or such person or entity against whom he has a reasonable objection. Nothing in these paragraphs circumvents the qualification requirements and the equipment substitution procedures and requirements.

6.06.B. After the execution of the Contract, a change in any approved Subcontractor or such person or entity or the addition of any new Subcontractor or person or entity can only be made with the written consent of the OWNER.

6.06.H. The CONTRACTOR agrees to bind every Subcontractor and such person or entity to the terms of the Contract as far as applicable to his work. The CONTRACTOR shall furthermore fully inform his Subcontractors prior to executing an agreement with them that they and the Subcontractors will be required to perform their work in conformance with the related documents and to submit cost estimates and change order proposals in complete and full analytical detail. The CONTRACTOR shall indemnify the OWNER for any Subcontractor's, Sub-Subcontractor's, or such person's or entity's claim which may result from the failure of the CONTRACTOR to incorporate the provisions in this Contract with any of his Subcontractors.

6.06.I. If, after approving a Subcontractor, or such person or entity, the OWNER or ENGINEER requires a change to another Subcontractor or such person or entity, the CONTRACTOR shall provide the OWNER with an itemized proposal for the cost increase or decrease by reason of such change. An equitable adjustment to the contract will then be determined by agreement between the contracting parties and contract so modified by Change Order. The adjustment shall be made in accordance with the administrative procedures for Change Orders set out in paragraph 11.4 below. If agreement on the adjustment cannot be reached, the matter will be handled as a dispute under the contract. Pending resolution, the Work will proceed using the selected Subcontractor, person or entity who is acceptable to the OWNER and the ENGINEER.

6.06.J. In addition to any bond required in the Bidding Documents of the CONTRACTOR or major Subcontractors, the OWNER may, at his option, require any Subcontractor or such person or entity to provide a satisfactory Performance Bond and Payment Bond of the type furnished by the CONTRACTOR. Bonds required at the option of the OWNER of such Subcontractors, person or entity shall meet the same requirements as specified in the Instructions to Bidders of the Supplementary General Conditions.

6.06.G. This Paragraph remains as written except where it might conflict with Subparagraph 6.06.H above, in which case the language in the latter shall prevail.

Safety And Protection:

Add the following sentences after paragraph 6.13.B.

The CONTRACTOR shall indemnify and hold harmless the OWNER, the Board and all its officers, agents, consultants, and employees, from all suits, action or claims of any character, name and description brought for or on account of any injuries or damages received or sustained by any person or property from said CONTRACTOR, his agents, Subcontractors, his/their employees, or by consequence of any negligence whatsoever. The OWNER by contract number shall be included as an additional insured on Worker's Compensation, General Liability, Automobile Liability and Umbrella policies.

ARTICLE 8: OWNER'S RESPONSIBILITIES & OTHER PROVISIONS

8.02.A. Delete paragraph 8.02.A. in its entirety.

Insert the following paragraphs at the end of Article 8.

8.12. The OWNER’S right to change, amend, delete from, add to, or in any manner modify this Contract or the Contract Documents in accordance with the terms and provisions thereof is hereby declared to be specific and absolute and without any duty or obligations on the part of OWNER to any Subcontractor, material men or other party having any contractual relationship with the CONTRACTOR. This Contract and the Contract Documents described herein shall be made a part of any and all subcontracts, agreements, or contractual arrangements between CONTRACTOR and any Subcontractor, material men, or other party; and, accordingly, the provisions of this Contract and the accompanying Contract Documents shall control and supersede the terms and provisions of any such subcontract or agreement between the CONTRACTOR and any other party.

8.13. Claims For Unpaid Labor And Materials:

8.13.1. The OWNER shall be furnished in accordance with Article 5160 of the Texas Revised Civil Statutes Annotated, a copy of the Payment Bond as required therein and by the Contract Documents. All claimants are cautioned that no lien exists on the funds unpaid to the CONTRACTOR on such Contract, and that reliance on notices sent to the OWNER may result in loss of their rights against the CONTRACTOR and/or his surety. The OWNER is not responsible in any manner to a claimant for collection of unpaid bills, and accepts no such responsibility because of any representation by any agent or employee.

ARTICLE 10: CHANGES IN THE WORK

Add the following sentences to paragraph 10.01.

It is recognized by the parties hereto, and agreed by them, that the specifications and drawings may or may not be complete, or free from error, omissions or imperfections, or otherwise may require changes or additions in order for the Work to be completed to the satisfaction of OWNER, and that, accordingly, it is the express intention of the parties (notwithstanding any other provisions in this Contract) that any errors, omissions or imperfections in such specifications and drawings or any changes in or additions to same, or to the Work, ordered by OWNER, and any resulting delays in the Work or increases in CONTRACTOR'S costs and expenses, shall not constitute or give rise to any claim, demand or cause of action of any nature whatsoever in favor of CONTRACTOR, whether for breach of contract, quantum merit, or otherwise; provided, however that OWNER shall be liable to CONTRACTOR for the sum stated to be due CONTRACTOR in any Change Order approved and signed by both parties, it being agreed hereby that such sum, together with any extension of time contained in said Change Order, shall constitute full compensation to CONTRACTOR for all costs, expenses and damages to CONTRACTOR, whether direct, consequential or otherwise in any wise incident to, arising out of, or resulting directly or indirectly from the Work performed by CONTRACTOR under such Change Order.

Add the following clauses to 10.01.

10.01.A. Such orders, designated or indicated to be Change Orders, include but are not limited to changes:

1. In the Specifications (including drawings and designs);
2. In the methods or manner of performance of the Work;
3. In the OWNER-furnished facilities, equipment, materials, services, or site, or;
4. Directing acceleration in the performance of the Work.

10.01.B. Any other written order or oral order (which terms as used in this clause 10.01.B shall include direction, instruction, interpretation, or determination) from the OWNER shall be treated as a Change Order under this Clause, provided that the CONTRACTOR gives the OWNER written notice stating the date, circumstances, and source of the order and that the CONTRACTOR regards the order as a Change Order.

ARTICLE 11: COST OF THE WORK; CASH ALLOWANCES; UNIT PRICE WORK

Delete paragraph 11.01 and all subparagraphs of 11.01 in its entirety and substitute the following:

11.01. Administrative Procedures for Change Orders: The following administrative procedures shall govern the submission and calculation of all Change Orders.

11.01.A. Contingency Allowance - Reference Division 1.

11.01.B. Lump Sum Proposal

11.01.B.1. In responding to a request for him to propose a price for a change in the Work, or in submitting a claim, the CONTRACTOR shall furnish a lump sum proposal supported by a complete breakdown as described hereafter, indicating the estimated or actual cost to the CONTRACTOR for performance of the changed Work, including the applicable percentage of overhead and profit described hereafter. Any request for an extension must be justified and presented in adequate detail to permit evaluation.

11.01.B.1.A. The proposal for the adjustment of the Subcontractor's Work or CONTRACTOR'S Work which he directly performs shall show cost of any extra Work and shall consist of the following items:

(1) Estimated cost, using any discounts to the trades, of the materials and supplies used, which shall be itemized completely to include unit cost, quantity and total cost.
(2) Estimated wages paid for skilled, semi-skilled or unskilled labor performing the additional Work, which shall be itemized completely to include trade(s) hourly rate, hours and total cost including those operating equipment if required. Such labor shall include labor required for performance of the changed Work only. Such labor may include working foremen, all other supervisors shall be excluded and shall be considered as a part of field supervision. Labor for supporting services, including but not limited to safety provisions, layout, and trash removal, shall be excluded and shall be considered as a part of overhead.
(3) Estimated cost for additional construction equipment solely for the use of the change order Work to include rental rates or owned equipment rates for such items of equipment while in use, which shall be itemized completely to include type(s), number(s) of each, hourly rate, hours and total cost. Equipment which is used regularly at the job shall be employed in change order Work at no extra charge. Rental or owned equipment rates shall be no greater than those established by the AGC for the local areas using current figures; if such current rates are unavailable, the rental or owned equipment rates shall not be greater than the average rate charged for equipment rental in the County of the project. As used herein the terms "construction equipment" and "equipment" shall include wheeled vehicles and small tools.
(4) Estimated transportation costs for delivery and handling of materials and supplies, bringing to and removing from the site additional construction equipment and/or new items of installed equipment, if applicable, which shall be itemized separately.
(5) Estimated off-site storage costs in excess of thirty (30) calendar days for new items or installed equipment, if applicable.
(6) Percentage permitted to be added to the total sum of a, b, c, d and e above to cover all field supervision use of other equipment on the job as necessary for economical performance of the Change Order Work, general office and field services and expenses, interference with other Work, adjustments to progress schedules and all other overhead (including bond and insurance) and profit shall be 10%.

(7) To the total cost proposed for the Change Order Work which is the sum of a, b, c, d, e, and f above, may be added the net cost of the following, if applicable: Social Security, Old Age Pension and/or other taxes of like nature imposed upon Subcontractor or CONTRACTOR (when he performs the Work) by the State or federal Government, or both, which are incident solely to such Change Order Work and which the CONTRACTOR would be required to pay if or as he performs the Work.

(8) All pricing shall be per the bid form proposal.

11.01.C. To the amount of the adjustment of the Subcontractor(s) as listed under 11.4.2.1.1 above, the CONTRACTOR will be allowed to add a percentage of 5% to cover all overhead expenses and profit, including supervisors, small tools, insurance and bond. It is to be expressly understood that when the CONTRACTOR performs the Work with his own forces, and where there is no Subcontractor involved, then the CONTRACTOR will be allowed the 10% mark-up described hereinbefore and the 5% mark-up is then not applicable. The term "Subcontractor" as used in 11.4.2.1.1. includes Subcontractors, whereby Subcontractors who perform the Work with their own forces will be entitled to receive the 10% mark-up.

11.01.D. If additional costs are claimed for unchanged Work, as provided in 11.3 above, the CONTRACTOR shall provide sufficient justification and description of such costs to permit evaluation by the OWNER and ENGINEER.

11.01.E. In cases where change in the Work results in credits to the OWNER, the credits shall be limited to direct costs; that is, no overhead or profit shall be charged to such costs. In cases where a change in the Work results in both credits and charges to the OWNER, the CONTRACTOR will be allowed to add the overhead and profit percentages indicated in 11.4.2.1.1 and 11.4.2.1.2 to the net charges, the amount by which the total charges exceeds the total credits; if there is a net credit, no overhead or profit shall be charged.

11.01.F. CONTRACTOR'S proposals for changes in the contract amount of time for Change Order Work shall be submitted within thirty (30) calendar days of the written request for same, unless the OWNER extends such period of time due to the circumstances involved. If such proposals are not timely received, or if such proposals are not acceptable to the ENGINEER and/or the OWNER, or if the changed Work should be started immediately, to avoid damage to the project or to avoid costly delay, the OWNER may, at his discretion and in the interest of prosecuting the Work to timely completion, direct the CONTRACTOR to proceed with the changed Work without waiting for the CONTRACTOR proposals or other cost and/or time estimates to be developed or the formal change to be issued. In the case of an unacceptable CONTRACTOR proposal, the OWNER’S directive to proceed with the changed Work shall be based on "a price not to exceed" the CONTRACTOR'S lump sum proposal. The estimated cost plus the marked-up percentages shall be determined at a later date in accordance with these articles, and said procedure shall be known as "PDL-NTE (Price Determined Later-Not To Exceed)". Such directions as may be given if given orally, shall be confirmed in writing within seven (7) calendar days. The cost or credit and time adjustments will be determined through negotiations as soon as practical thereafter and incorporated in a change order to the Contract. Prior to such negotiations, the CONTRACTOR shall keep separate costs on Change Order Work done up to that point.

11.01.G. Processing:

The OWNER will undertake to formally process and issue OWNER-CONTRACTOR agreed Change Orders within thirty (30) calendar days of such agreement, provided the contingency allowance is not exceeded. In those cases where Change Order Work causes the contingency allowance to be exceeded, approval of high authority will be necessary and, if such approvals are necessary, the OWNER will have ninety (90) additional calendar days to process and issue such agreed Change Orders.

11.01.H. Unilateral Change Order: In the event that the OWNER requires certain Work to be accomplished and the CONTRACTOR fails in the discharge of any or all of his responsibilities described hereinbefore, the OWNER may issue a unilateral Change Order which is a Change Order issued by or at the direction of the OWNER without the full timely agreement of the CONTRACTOR.

11.01.H.A. A unilateral Change Order may be issued before, during or after the changed Work is physically accomplished under the following conditions.

(1) The CONTRACTOR fails to submit price and/or time extension proposal of the changed Work within thirty (30) days of receipt of the request for proposals or within a reasonable time thereafter as specified by the OWNER; or
(2) Negotiation fails to achieve an agreed price and/or time extension or there remains a disagreement concerning any part of the changed Work; or
(3) The CONTRACTOR fails or refuses to execute a Change Order by affixing his signature thereto within thirty (30) days of receipt provided that he has had opportunity to state his objections, and, if stated, they are not mutually resolved.
(4) The OWNER shall notify the CONTRACTOR in writing that the Change Order is considered to be unilateral and is to be an effective change to the Contract. A notation will be made on the face of the Change Order that it is unilateral and the effective date thereof. Normal distribution of copies will then be made.

11.01.H.B. The terms of a unilateral Change Order including the change in contract price and/or completion date shall be determined by the OWNER assisted by the ENGINEER and shall, in the OWNER'S judgment, be fair and reasonable.

11.01.H.C. When a unilateral Change Order has been issued, it will have the full force and effect of a contract modification. It will be included in schedules, payment estimates, reports and all official records of the Contract. The assurance of a unilateral Change Order will not prejudice any of the CONTRACTOR'S rights to make claims or to appeal disputed matters under other provisions of this Contract.

11.01.H.D. If the CONTRACTOR objects to a unilateral Change Order, he shall state in writing his specific objections to or specific points of disagreements with the Work described in the unilateral Change Order within (30) days of receipt of such Change Order.

11.01.I. Except as provided above, no order, oral statement or directive of the OWNER of his duly appointed representative shall be treated as a change order under this article or entitle the CONTRACTOR to an adjustment thereunder.

Contractor's Fee:

Delete paragraphs 12.01.C and 11.01.D and all subparagraphs of 12.01.C. See Supplementary Conditions Articles 11 and 12.

Unit Price Work:

Delete paragraphs 11.03.A and 11.03.C. See Supplementary Conditions Article 11.

Concealed Conditions (New):

Insert the following at the end of Article 11:

11.04. Should concealed conditions encountered in the performance of the Work below the surface of the ground or should concealed or unknown conditions in an existing structure be at variance with the conditions indicated by the Contract Documents, or should unknown physical conditions below the surface of the ground or should concealed or unknown conditions in an existing structure of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in this Contract, be encountered, the Contract Sum shall be equitably adjusted by Change Order upon claim by either party made within twenty days after the first observance of the conditions.

11.04.A. Notwithstanding paragraph 11.10 above, the CONTRACTOR is responsible for having visited the site and having ascertained pertinent local conditions such as location, accessibility, and general character of the site or building, the character and extent of existing Work within the adjacent submission of his proposal. Any failure to do so will not relieve him from responsibility for successfully performing the work without additional expense to the OWNER.

11.04.B. The OWNER makes no representations as to the accuracy or completeness of the site information furnished to the CONTRACTOR by OWNER and does not expressly or impliedly warrant same and is not responsible for any interpretations or conclusions reached by the CONTRACTOR with respect thereto. It is the CONTRACTOR'S sole responsibility to verify to its own satisfaction all site information, including but not restricted to topographical data, borings, subsurface information, utilities, easements, and existing buildings.

Claims For Additional Cost (New):

11.05. Claims for additional costs shall be in accordance with Supplementary Conditions Article 11. If the OWNER and CONTRACTOR cannot agree on the amount of the adjustment in the Contract Sum, it shall be determined by the ENGINEER in accordance with the administrative procedure for Change Orders set out in Supplementary Conditions - Article 11. No claim shall be allowed for an equitable adjustment under this or any other provision of the Contract Documents if asserted after Final Payment.

ARTICLE 12: CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

Delete paragraph 12.01.B and all subparagraphs of 12.01.B in its entirety and substitute the following:

12.01.B If such changes cause an increase or decrease in the CONTRACTOR'S cost of, or time required for performance of the Contract, an equitable adjustment shall be made and confirmed in writing in a Change Order.

12.01.B.1. Except for claims based on defects in specifications furnished by the OWNER, no claim for any change under 10.01.A above shall be allowed for any costs incurred more than twenty (20) days before the CONTRACTOR gave written notice as therein required; provided that, in the case of defects in specifications furnished by the OWNER, the equitable adjustment shall include only those increased direct costs reasonably and necessarily incurred by the CONTRACTOR as a result of such specifications.

12.01.B.2. Procedures for administration of Change Orders are stated in paragraph.

12.01.B.3. If the CONTRACTOR intends to assert a claim for an adjustment of cost or time over and above any adjustment already being granted in a Change Order, he must, within thirty (30) calendar days after receipt of a written Change Order; or oral or written order to proceed with a proposed change under Clause 10.1.1 or the furnishing of a written notice under Clause 10.1.2 submit to the OWNER a written statement setting forth in detail the nature and monetary extent of such claim. The CONTRACTOR shall certify that the claim is made in good faith and that the supporting data is current, accurate and complete to the best of his knowledge and belief, and that the amount requested accurately reflects the contract adjustment for which the CONTRACTOR believes the OWNER is liable. Failure to certify a claim will result in a determination that no claim has been filed. The 30 day period of time for submission of such claim may be extended only by written agreement signed by the OWNER. Except for claims based upon defects in specifications furnished by the OWNER, no claim for any change under Clause 10.1.2 above, shall be allowed for any costs incurred more than twenty (20) days before the CONTRACTOR gave written notice as therein required; provided that in the case of defects in specifications furnished by the OWNER the adjustment in cost shall include only those increased direct costs reasonably and necessarily incurred by the CONTRACTOR as a result of such defective specifications.

12.01.B.4. Except as provided above, no order, oral statement or directive of the OWNER or his duly appointed representative shall be treated as a change under his Article or entitle the CONTRACTOR to an adjustment thereunder.

Delete all of paragraph 12.02 and substitute the following: The Contract Time may only be changed by a Change Order processed in accordance with Supplementary Conditions or Article 11.

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

Application For Progress Payment:

Add the following clauses 14.02.A.1 and 14.02.A.2 to 14.02.A:

14.02.A.1. Unless otherwise stated in the Agreement, the OWNER will retain 5% of the amount of each estimate except as otherwise provided in Contract Documents. Retained percentage will be held until final completion and acceptance of the work. Progress payments shall be on AIA forms with schedule of values.

14.02.A.2. The itemized Application for Payment shall be notarized.

Review Of Applications For Progress Payment:

14.02.B. Modify paragraph 14.02.B to make payment due in accordance with Agreement signed.

Final Inspection, Final Applications For Payment And Final Payment And Acceptance:

Delete paragraphs 14.06, 14.07.A, 14.07.B, and 14.08. in their entirety and substitute the following:

14.06. When the Work is completed, the CONTRACTOR shall notify the ENGINEER in writing that the Work will be ready for final inspection on a definite date. Upon verification by the ENGINEER that the Work is ready for final inspection and acceptance, the OWNER will within ten (10) calendar days make a final inspection and, when the Work is found acceptable under the Contract Documents and the Contract is fully performed, make final payment to the CONTRACTOR.

14.06.A. To avoid delay in final payment, the CONTRACTOR shall have all necessary bonds, guarantees not previously furnished, receipts, releases, affidavits, etc. prepared and signed in advance with a letter of transmittal listing each paper to be furnished to the OWNER at the time of final inspection.

14.07.A. The CONTRACTOR shall be charged with any additional cost of inspection when material and workmanship are not ready at the time specified by the CONTRACTOR for its inspection.

14.07.B. Upon acceptance of the Contract work, the ENGINEER shall execute an acceptance document in accordance with the Contract Agreement and deliver such document to the CONTRACTOR by mail or other means within ten (10) calendar days. The CONTRACTOR'S requirement for insurance coverage of the Work may be terminated on the date of the executed final acceptance document. In the case where heating and ventilating, air conditioning or other systems must be tested seasonally, the OWNER may accept the Work less such testing and final acceptance of such systems will be accomplished after completion of successful tests.

14.07.B.1. Upon execution of the acceptance document by the ENGINEER, the CONTRACTOR shall submit a request for final payment signed by a CONTRACTOR principal. Such request shall be marked "Final Payment" by the CONTRACTOR. This request shall be approved and certified by the ENGINEER and forwarded to the OWNER. If the OWNER determined that all the Work under the Contract has not been satisfactorily completed, he will advise the CONTRACTOR in writing within ten (10) calendar days of receipt of the request for final payment of the reasons that final payment is being retained. The CONTRACTOR shall complete such remaining Work within thirty (30) days. The OWNER will then promptly process final payment.

14.07.B.2. With the application for final payment the CONTRACTOR shall deliver to the ENGINEER (1) an affidavit that all payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the OWNER or his property might in any way be responsible, have been paid or otherwise satisfied, (2) consent of surety, if any, to final payment, and (3) if required by the OWNER, other data establishing payment or satisfaction of all such obligations, such as receipts, releases and waivers of liens arising out of the Contract, to the extent and in such form as may be designated by the OWNER. If any Subcontractor refuses to furnish a release or waiver required by the OWNER to indemnify him against any such lien, or any such lien remains unsatisfied after all payments are made, the CONTRACTOR shall refund to the OWNER all moneys that the latter may be compelled to pay in discharging such liens, including all costs and reasonable attorneys' fees.

14.07.B.3. Unless otherwise provided in this Contract, acceptance by the ENGINEER shall be made as promptly as practicable after completion and inspection by the OWNER of all the Work required by this Contract. Acceptance shall be final and conclusive except as regards latent defects, fraud or such gross mistakes as may amount to fraud or as regards the OWNER'S rights under any warranty or guarantee.

14.07.B.4. No claim by the CONTRACTOR shall be allowed if asserted after final payment under this contract.

ARTICLE 16 DISPUTE RESOLUTION

Add the following statement at the end of Article 16.

Owner requires Contractor, Subcontractor, Vendors, and Suppliers to waive subrogation against Owner and Engineer.

Mediation shall be the first method of non-binding dispute resolution. Mediation shall occur in Tyler, TX, Smith County.

ARTICLE 17 - MISCELLANEOUS

17.06. Antitrust Claims (New):

17.06.1. The CONTRACTOR hereby assigns to the OWNER any and all claims for overcharges associated with the Contract which arise in any manner under the Antitrust laws of the United States, 15 U.S.C. Section 1 et. seq. (1973), as amended.

17.07. Owner's Occupancy (New):

17.07.1. The CONTRACTOR shall allow the OWNER to place and install OWNER'S equipment, etc., during construction work. The CONTRACTOR will provide a schedule, approved by the ENGINEER, for OWNER'S occupancy relative to the installation of equipment. Such placing and installing of equipment, etc., shall not in any way evidence the completion of the work or any portion of it, or signify the OWNER'S acceptance of the work or any part of it.

17.08. Completion Of Work (New):

17.08.1. The CONTRACTOR will be held to account for the Work being completed in the time that is stated in the Contract.

17.08.2. If, in the judgment of the OWNER, the Work is behind schedule and the rate of placement of work is inadequate to regain scheduled progress so as to insure timely completion of the entire work or a separable portion thereof, the CONTRACTOR, when so informed by the OWNER, shall immediately take action to increase the rate of work placement. This increase shall be accomplished by any one or a combination of the following or other suitable measures: (1) an increase in working forces, (2) an increase in equipment or tools, (3) an increase in hours of work or number of shifts, and/or (4) Expedite delivery of materials.

17.08.3. The CONTRACTOR shall, within ten (10) calendar days after being so informed, notify the OWNER of the specific measures taken and/or planned to increase the rate of progress together with an estimate as to when scheduled progress will be regained. Should the plan of action be deemed inadequate by the OWNER, the CONTRACTOR will take additional steps or make adjustments as necessary to his plan of action until it meets with the OWNER'S approval. The

acceleration of Work will continue until scheduled progress is regained. Scheduled progress will be established from the latest revised approved progress schedule for the job. Timely completion will be understood as the contract completion date is revised by all-time extensions granted at the time acceleration is undertaken. The CONTRACTOR shall not be entitled to additional compensation for the additional effort he applies to the Work under the terms of this sub-paragraph.

17.08.4. Failure of the CONTRACTOR to comply with the requirements of the OWNER under this provision shall be grounds for determination that the CONTRACTOR is guilty of a substantial violation of a provision of the Contract Documents. Upon such determination, the OWNER may terminate the Contract.

17.08.5. Any directive or order to accelerate the Work will be in writing. Any directive or order terminating accelerated Work will be in writing.

17.09. The CONTRACTOR agrees that the Work shall be executed regularly, diligently and without interruption at such rate of progress as will insure completion thereof within the time specified in the contract document. It is expressly understood and agreed by and between the CONTRACTOR and the OWNER, that time is of the essence and that the time of the completion of the work in the contract documents is a reasonable time in which to complete such specified work.

17.10. Contract Warranty And Guarantee After Final Acceptance (New)

17.10.1. One Year Warranty:

17.10.1. Except as otherwise specified, the CONTRACTOR warrants and guarantees all work against defects in materials, equipment or workmanship for one (1) year from the date of Substantial Completion.

17.10.1.2. Upon receipt of written notice from the OWNER of the discovery of any defects, the CONTRACTOR shall remedy the defects and replace any property damaged therefrom occurring within the warranty and guarantee period.

17.10.1.3. In case of Work performed by Subcontractors and where guarantees are required, the CONTRACTOR shall secure warranties from said Subcontractors addressed to and in favor of OWNER, deliver copies of same to ENGINEER upon completion of the Work, guarantee and assume full responsibility for the full period of said warranties. Delivery of said guarantees shall not relieve the CONTRACTOR from any obligations assumed under any other provisions of the Contract.

17.10.1.4. This warranty and guarantee is not the exclusive remedy of the OWNER, but is in addition to the general obligation of the CONTRACTOR to faithfully perform the Contract, and it in no way relieves the CONTRACTOR'S responsibility for faulty materials or workmanship.

17.10.1.5. Neither the final payment nor any provision of the Contract Documents shall relieve the CONTRACTOR of responsibility for faulty materials or workmanship. If the CONTRACTOR, after notice, fails to proceed promptly to comply with the terms of the warranty and guarantee, the OWNER may have the defects corrected and the CONTRACTOR and his surety shall be liable for all expenses incurred.

17.10.1.6. The provisions of these 17.10 paragraphs and sub-paragraphs are in addition to the provisions found in the General Conditions.

17.11. Other Owner Requirements:

17.11.1. CONTRACTOR shall provide all equipment, materials and labor to complete the turnkey work as described in these specifications. All bidders and successful CONTRACTORS shall comply with the special conditions, Division O requirements, Division 1 requirements, Division 15 requirements, Division 16 requirements, and all other Divisions included in this project manual. Bidders submitting proposals which do not comply shall not be considered.

17.11.2. The Bidders shall have been in business for seven continuous years under the company bidding.

17.11.3. OWNER will provide access to the work site. OWNER'S personnel will provide on-site acceptance inspection for compliance with the specifications contained herein and in manufacturer's installation instructions, but exclusive of any inspection required by federal, state or local authority.

17.11.4. Safety Instructions:

No asbestos containing materials will be utilized.

No rigging of equipment over occupied areas.

General safety rules must be followed at all times.

Electrical work must be installed per National Electric Code.

CONTRACTOR is responsible for all damages caused by their employees or representatives in the performance of this contract (i.e. holes in walls, roof leaks, ceiling tiles damaged, equipment and furnishings damage, concrete and grounds damaged from vehicle or heavy equipment, etc.).

CONTRACTOR is solely responsible for means and methods, fire protection, and code/standard compliance.

17.11.5. Smoking and other use of tobacco products on the campus is prohibited.

All work and scheduling shall be coordinated with OWNER'S Representative.

17.11.6. All work shall be scheduled and accomplished without interrupting OWNER'S operations, classes or other school functions.

17.11.7. For pre-bid CONTRACTOR inspection, all CONTRACTORS must identify themselves at the school office PRIOR to touring the site.

17.11.8. All operation and maintenance manuals, bulletins, instruction brochures, guarantees, etc. shall be given to the ENGINEER

17.11.9. Compliance Requirements:

The following contract provisions or conditions shall apply:

CONTRACTORS and/or Subcontractors shall be in compliance with Federal Executive Order 11246, entitled "Equal Employment Opportunity", as amended by Executive Order 11375, and as supplemented in Department of Labor Regulations (41 CFR Part 60).

CONTRACTORS and/or Subcontractors shall be in compliance with the Copeland "Anti-Kickback" Act (18 USD 874) as supplemented in Department of Labor Regulations (29CFR, Part 3). This Act provides that each CONTRACTOR and/or Subcontractor shall be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation, to which he is otherwise entitled. School districts shall report all suspected or reported violations to the Texas Education Agency.

CONTRACTORS and/or Subcontractors shall be in compliance with Section 103 and 107 of the Contract Work Hours and Safety Standards Act (40 USC 327-330) as supplemented by Department of Labor Regulations (29 CFR, Part 5). Under Section 103 of the Act, each CONTRACTOR and/or Subcontractor shall be required to compute the wages of every mechanic and laborer on the basis of a standard workday of eight hours and a standard workweek of 40 hours. Work in excess of eight hours per day or 40 hours per week shall be compensated at a rate of not less than 1½ times the basic rate of pay. Section 107 of the Act is applicable to construction work and provides that no laborer or mechanic shall be required to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety as determined under construction, safety and health standards promulgated by the Secretary of Labor.

The Texas Education Agency, the Comptroller General of the United States, or any of their duly authorized representatives, shall have access to any books, documents, papers, and records of the CONTRACTOR and/or Subcontractor which are directly pertinent to the specific contract, for the purpose of making audit, examination, excerpts, and transcriptions. CONTRACTORS and/or Subcontractors shall maintain all required records for five (5) years after final payments and all other pending matters are closed.

CONTRACTORS and/or Subcontractors shall be in compliance with all applicable standards, orders, or requirements issued under Section 306 of the Clean Air Act (42 USC 1857 (a)), Section 508 of the Clean Water Act (33 USC 1368), Executive Order 11378, and Environmental Protection Agency Regulations (40 CFR, Part 15), which prohibits the use under non-exempt federal contracts, grants, or loans of facilities included on the EPA list of violating facilities. The provision shall require reporting of violations to the Texas Education Agency and to the USEPA Assistant Administrator for Enforcement (EN-329).

Contracts shall recognize mandatory standards and policies relating to energy efficiency which are contained in the State energy conservation plan issued in compliance with the Energy Policy and Conservation Act (P.L.94-163).

17.11.10. Attachment B Insurance (6 pages).

END OF SUPPLEMENTARY GENERAL CONDITIONS

Employment Eligibility Verification

Department of Homeland Security
U.S. Citizenship and Immigration Services

USCIS
Form I-9
OMB No. 1615-0047
Expires 10/31/2022

►START HERE: Read instructions carefully before completing this form. The instructions must be available, either in paper or electronically, during completion of this form. Employers are liable for errors in the completion of this form.

ANTI-DISCRIMINATION NOTICE: It is illegal to discriminate against work-authorized individuals. Employers **CANNOT** specify which document(s) an employee may present to establish employment authorization and identity. The refusal to hire or continue to employ an individual because the documentation presented has a future expiration date may also constitute illegal discrimination.

Section 1. Employee Information and Attestation *(Employees must complete and sign Section 1 of Form I-9 no later than the **first day of employment**, but not before accepting a job offer.)*

Last Name *(Family Name)*	First Name *(Given Name)*	Middle Initial	Other Last Names Used *(if any)*

Address *(Street Number and Name)*	Apt. Number	City or Town	State	ZIP Code

Date of Birth *(mm/dd/yyyy)*	U.S. Social Security Number	Employee's E-mail Address	Employee's Telephone Number
	☐☐☐ - ☐☐ - ☐☐☐☐		

I am aware that federal law provides for imprisonment and/or fines for false statements or use of false documents in connection with the completion of this form.

I attest, under penalty of perjury, that I am (check one of the following boxes):

☐ 1. A citizen of the United States

☐ 2. A noncitizen national of the United States *(See instructions)*

☐ 3. A lawful permanent resident (Alien Registration Number/USCIS Number): _____

☐ 4. An alien authorized to work until (expiration date, if applicable, mm/dd/yyyy): _____
Some aliens may write "N/A" in the expiration date field. *(See instructions)*

Aliens authorized to work must provide only one of the following document numbers to complete Form I-9: An Alien Registration Number/USCIS Number OR Form I-94 Admission Number OR Foreign Passport Number.

1. Alien Registration Number/USCIS Number: _____

OR

2. Form I-94 Admission Number: _____

OR

3. Foreign Passport Number: _____

Country of Issuance: _____

QR Code - Section 1
Do Not Write In This Space

Signature of Employee	Today's Date *(mm/dd/yyyy)*

Preparer and/or Translator Certification (check one):

☐ I did not use a preparer or translator. ☐ A preparer(s) and/or translator(s) assisted the employee in completing Section 1.

(Fields below must be completed and signed when preparers and/or translators assist an employee in completing Section 1.)

I attest, under penalty of perjury, that I have assisted in the completion of Section 1 of this form and that to the best of my knowledge the information is true and correct.

Signature of Preparer or Translator	Today's Date *(mm/dd/yyyy)*

Last Name *(Family Name)*	First Name *(Given Name)*

Address *(Street Number and Name)*	City or Town	State	ZIP Code

STOP *Employer Completes Next Page* STOP

Section 2. Employer or Authorized Representative Review and Verification

(Employers or their authorized representative must complete and sign Section 2 within 3 business days of the employee's first day of employment. You must physically examine one document from List A OR a combination of one document from List B and one document from List C as listed on the "Lists of Acceptable Documents.")

Employee Info from Section 1	Last Name *(Family Name)*	First Name *(Given Name)*	M.I.	Citizenship/Immigration Status

List A Identity and Employment Authorization	OR	List B Identity	AND	List C Employment Authorization
Document Title		Document Title		Document Title
Issuing Authority		Issuing Authority		Issuing Authority
Document Number		Document Number		Document Number
Expiration Date *(if any) (mm/dd/yyyy)*		Expiration Date *(if any) (mm/dd/yyyy)*		Expiration Date *(if any) (mm/dd/yyyy)*
Document Title				
Issuing Authority				
Document Number				
Expiration Date *(if any) (mm/dd/yyyy)*				
Document Title				
Issuing Authority				
Document Number				
Expiration Date *(if any) (mm/dd/yyyy)*				

Additional Information

QR Code - Sections 2 & 3
Do Not Write In This Space

Certification: I attest, under penalty of perjury, that (1) I have examined the document(s) presented by the above-named employee, (2) the above-listed document(s) appear to be genuine and to relate to the employee named, and (3) to the best of my knowledge the employee is authorized to work in the United States.

The employee's first day of employment *(mm/dd/yyyy)*: _____ ***(See instructions for exemptions)***

Signature of Employer or Authorized Representative	Today's Date *(mm/dd/yyyy)*	Title of Employer or Authorized Representative

Last Name of Employer or Authorized Representative	First Name of Employer or Authorized Representative	Employer's Business or Organization Name

Employer's Business or Organization Address (*Street Number and Name*)	City or Town	State	ZIP Code

Section 3. Reverification and Rehires *(To be completed and signed by employer or authorized representative.)*

A. New Name *(if applicable)*			**B.** Date of Rehire *(if applicable)*
Last Name *(Family Name)*	First Name *(Given Name)*	Middle Initial	Date *(mm/dd/yyyy)*

C. If the employee's previous grant of employment authorization has expired, provide the information for the document or receipt that establishes continuing employment authorization in the space provided below.

Document Title	Document Number	Expiration Date *(if any) (mm/dd/yyyy)*

I attest, under penalty of perjury, that to the best of my knowledge, this employee is authorized to work in the United States, and if the employee presented document(s), the document(s) I have examined appear to be genuine and to relate to the individual.

Signature of Employer or Authorized Representative	Today's Date *(mm/dd/yyyy)*	Name of Employer or Authorized Representative

LISTS OF ACCEPTABLE DOCUMENTS
All documents must be UNEXPIRED

Employees may present one selection from List A
or a combination of one selection from List B and one selection from List C.

LIST A Documents that Establish Both Identity and Employment Authorization	OR	LIST B Documents that Establish Identity	AND	LIST C Documents that Establish Employment Authorization
1. U.S. Passport or U.S. Passport Card		**1.** Driver's license or ID card issued by a State or outlying possession of the United States provided it contains a photograph or information such as name, date of birth, gender, height, eye color, and address		**1.** A Social Security Account Number card, unless the card includes one of the following restrictions: (1) NOT VALID FOR EMPLOYMENT (2) VALID FOR WORK ONLY WITH INS AUTHORIZATION (3) VALID FOR WORK ONLY WITH DHS AUTHORIZATION
2. Permanent Resident Card or Alien Registration Receipt Card (Form I-551)		**2.** ID card issued by federal, state or local government agencies or entities, provided it contains a photograph or information such as name, date of birth, gender, height, eye color, and address		**2.** Certification of report of birth issued by the Department of State (Forms DS-1350, FS-545, FS-240)
3. Foreign passport that contains a temporary I-551 stamp or temporary I-551 printed notation on a machine-readable immigrant visa		**3.** School ID card with a photograph		**3.** Original or certified copy of birth certificate issued by a State, county, municipal authority, or territory of the United States bearing an official seal
4. Employment Authorization Document that contains a photograph (Form I-766)		**4.** Voter's registration card		**4.** Native American tribal document
5. For a nonimmigrant alien authorized to work for a specific employer because of his or her status: **a.** Foreign passport; and **b.** Form I-94 or Form I-94A that has the following: (1) The same name as the passport; and (2) An endorsement of the alien's nonimmigrant status as long as that period of endorsement has not yet expired and the proposed employment is not in conflict with any restrictions or limitations identified on the form.		**5.** U.S. Military card or draft record		**5.** U.S. Citizen ID Card (Form I-197)
		6. Military dependent's ID card		**6.** Identification Card for Use of Resident Citizen in the United States (Form I-179)
		7. U.S. Coast Guard Merchant Mariner Card		**7.** Employment authorization document issued by the Department of Homeland Security
		8. Native American tribal document		
		9. Driver's license issued by a Canadian government authority		
		For persons under age 18 who are unable to present a document listed above:		
6. Passport from the Federated States of Micronesia (FSM) or the Republic of the Marshall Islands (RMI) with Form I-94 or Form I-94A indicating nonimmigrant admission under the Compact of Free Association Between the United States and the FSM or RMI		**10.** School record or report card		
		11. Clinic, doctor, or hospital record		
		12. Day-care or nursery school record		

Examples of many of these documents appear in the Handbook for Employers (M-274).

Refer to the instructions for more information about acceptable receipts.

SECTION 01 00 00

GENERAL REQUIREMENTS

1. Work Included: Furnishing of all coordination, labor, superintendence, materials, tools, cranes, equipment and sources necessary for the complete installation or modification of the following systems as shown on the plans and as herein specified. It is the intent of these specifications that the Contractor shall furnish and install a system complete in every respect and ready to operate. All miscellaneous items and accessories required for such installation and for the correct and convenient operation of the entire installation whether or not each such item or accessory is shown on the plans or mentioned in these specifications shall be furnished and installed. Drawings and Division 0 apply to this Section.

2. Codes, Standards, and Permits: Comply with all local requirements. All work shall be in strict accordance with all applicable laws and codes, including but not limited to the following:
   a. National Electrical Code; Latest Edition
   b. Occupational Safety and Health Administration Standards including (but not limited to) OSHA Standard 2207 - Construction Industry Standards
   c. Applicable State Codes & Laws
   d. City Codes and Code Modifications, & Adopted Codes & Ordinances.
   e. National Fire Protection Association
   f. Texas Department of Health
   g. Standard Building Code - 1994 Edition
   h. Vernon's Law - State of Texas
   i. Standard Mechanical Code - 1994 Edition
   j. Standard Plumbing Code - 1994 Edition
   k. Environmental Protection Agency
   l. Standard Gas Code - 1994 Edition
   m. Texas Department of Labor Boiler Rules and Regulations
   n. NFPA 90A
   o. American Society of Heating, Refrigerating, and Air Conditioning Engineers.
   p. Clean Air Act and Amendments.

   Nothing in the plans or specifications shall be construed to permit work not conforming to these codes. In all cases of difference between minimum requirements of the various laws, codes and authorities, it is intended that the work shall meet the more stringent requirements.

   The Contractor shall procure all necessary permits or licenses to carry out his work and pay the lawful fees therefore; he shall also obtain and pay for all the necessary certificates of approval which must be delivered to the Owner before final acceptance of the work.

   The Contractor and Subcontractors shall contact the City and obtain and verify all codes, ordinances, and regulations before beginning work. The Contractor and Subcontractors are responsible for complying with all codes, ordinances, and regulation requirements, and ensuring that current codes are used.

3. Guarantee: The Contractor shall guarantee his work against defective materials and workmanship for a period of one year from date of acceptance of the job. Neither the final payment nor any provisions in Contract documents shall relieve the Contractor of the

responsibility for faulty materials and workmanship; he shall remedy any defects due thereto, and pay for any damage to other work resulting therefrom, which shall appear within a period of one year from date of substantial completion.

4. Submittals: The Contractor shall submit to the Engineer for review six copies of the material to be used on this job. This submittal shall include all data as well as the manufacturer's name and catalog number.

The review of such plans shall not relieve the Contractor of responsibility for deviation from the Contract plans or specifications.

Shop drawings and samples per General Conditions. Contractor shall submit shop drawings and samples accompanied by transmittal forms.

Construction schedule per General Conditions shall be submitted.

5. Project Closeout:

Cleaning Up: Upon completion of the work, remove surplus materials and rubbish of every kind from the site of the work.

Documents Required Prior to Final Payment: Prior to final payment, and before the issuance of a final certificate for payment in accordance with the provisions of the NSPE General Conditions, file the following notarized papers with the Engineer.

Documents:
Final Certificate for Payment
- Contractor's Affidavit of Payment of Debts and Claims (AIA G706)
- Contractor's Affidavit of Release of Liens (AIA G706A)
- Release of Claims and Waiver of Lien for Subcontractor, Materialmen or Material Fabricators.

Guarantees: The guarantee required by the General Conditions and any other extended guarantee stated in the technical sections of the specifications. Start date of warranty shall be the date of final completion.

Operation and Maintenance Manuals: Furnish as specified under the various sections of the Specifications.

Asbestos certification letter that no asbestos was provided in this project.

Project Record Documents: As the work progresses, keep a complete and accurate record of changes or deviations from the Contract Documents and the shop drawings, indicating the work as actually installed. Changes shall be neatly and correctly shown on the respective portion of the affected document, using blue line prints of the Drawings affected or the Specifications, with appropriate supplementary notes. This record set of Drawings, shop drawings, and Specifications shall be kept at the job site for inspection by the Engineer and Owner.

The records above shall be arranged in order, in accordance with the various sections of the specifications, and properly indexed. At the completion of the work, certify by endorsement thereon that each of the revised prints of the Drawings and Specifications is complete and accurate. Prior to application for final payment, and as a condition to its approval by the Engineer and Owner, deliver the record set of Drawings and Specifications, arranged in proper order, indexed, and endorsed as hereinbefore specified.

No review or receipt of such records by the Engineer or Owner shall be a waiver of any deviation from the Contract Documents or the shop drawings or in any way relieve the Contractor from his responsibility to perform the work in accordance with the Contract Documents and the shop drawings to the extent that they are in accordance with the Contract Documents.

6. The project site shall be kept free of accumulation of surplus materials and rubbish during construction. Upon the completion of the project all debris shall be removed and the site shall be left clean. During the school term the contractor and subcontractors shall clean-up daily the area where work is performed. If it is necessary for the school to clean up after the contractor or subcontractor, the Owner reserves the right to keep track of costs and bill the Contractor. The Contractor and Subcontractors shall cooperate with the school.

7. Asbestos:
Asbestos work is specifically excluded from this contract. The Contractor and Subcontractors shall communicate directly and separately from the Engineer with Owner in all decisions involving asbestos or whether a material is asbestos.

8. The Division 0, Division 23, Division 26, and General Provisions Division - 1 supplement and modify the Contract Documents and shall form a part of the Contract and all Subcontracts.

9. The project site shall be cleaned-up before final inspection and payment.

10. All trades shall have proper licenses as required by the City where the project is located. It is the responsibility of the General Contractor to verify that all subcontractors have proper required licenses.

11. Special Site Conditions:
    a. All work is to be carried out as quietly and dust free as possible. Noise, vibration, and disturbance shall be kept to a minimum and work shall be accomplished in accordance with local ordinances. Keep the premises free of accumulations of surplus materials and rubbish, and in an orderly condition at all times.
    b. In the event any work is accomplished during the school year when classes are in session, or during office hours, work shall be conducted in a manner that will not interfere with, be disruptive, or distractive to the classes or office. Contractor work schedules during the school term and office hours shall be coordinated with the Owner's representative. Entrance to buildings after school hours or during times when the building is normally closed is the responsibility of the Contractor. The Contractor is responsible for obtaining keys or coordinating with school personnel to obtain access and to secure the building. The Contractor shall become familiar with space limitations and traffic patterns.

The campus custodians are charged with having their buildings clean and ready for school each day. The Contractor will be cognizant of this important factor and make every effort to complete each area of construction in a timely manner to allow the campus custodians to move in and complete their work. Contractor is responsible for cleaning of their own related work.

c. Work accomplished during the non-regular school term and hours shall be coordinated with Owner's Representative for building security, and routine school cleaning and maintenance. Contractors shall coordinate and cooperate with Owner to ensure building is ready for the next scheduled use. The Contractor shall be responsible for building security and coordinating security with Owner's Representative. The Contractor shall coordinate and cooperate with any school activities and schedule.

d. The Owner reserves the right to have their personnel and other Contractors working in the building. The Owner reserves the right to partially occupy the building in completed areas prior to Completion.

e. Keep public areas such as halls, stairs, etc. free from accumulation of waste and construction debris. Smoking or open fires will not be permitted within the building enclosure or on the premises.

f. Use of the existing toilets within the building by the Contractor, and his personnel will not be permitted.

g. Maintain the building in a safe and weather tight condition at all times.

12. Protection of Owner's Operations:

The Contractor is herewith advised that his operations and the operations of any and all subcontractors will be required to be coordinated with the Owner. Other services shall be limited to non-school hours. Temporary outages of electrical power and plumbing shall be limited to non-school hours.

All buildings are equipped with burglar alarm systems. Any work to be done during off hours will require notification of the Owner's representative three (3) days prior in order for the Owner to arrange for disarming and rearming of burglar systems.

Should the Contractor damage Owner's utility lines or apparatus and the Owner be called to make timely repairs, the Contractor will be invoiced based upon current Owner's overtime expenses.

13. Contractor's Affidavit:

After completion of the work contemplated by this Contract, the Contractor shall file with the Owner his affidavit, sworn to before a Notary Public, stating that all workmen and persons employed, all firms supplying the materials and all subcontractors upon the project have been paid in full and that there are no bills outstanding against the project for either labor or materials, except certain items, if any, to be set forth in such affidavit covering disputed claims.
The filing of such affidavit by the Contractor shall be prerequisite to the making by the Owner of the final payment to the Contractor.

14. Exposed conduit will not be allowed in occupied areas or spaces. Exposed conduit will not be allowed in the halls below the ceiling. Exposed conduit in normally unoccupied areas will be permitted only after approval of Engineer and Owner. Any exposed conduit permitted shall be wiremold.

15. This project shall be accomplished in a neat and good workmanship manner using accepted methods. Wiring, panels, etc. shall be neat and orderly in appearance. Loose, tangled wires, etc. will not be accepted. The final work shall be complete and finished.

16. Each Contractor and Subcontractor is responsible for cleaning up and removing their own debris, dust, trash, etc. Any damage to the school or school equipment or school supplies requiring repair shall be accomplished by Contractor or Subcontractor doing damage. Spillage, over spray, collections of dust and debris, and damage to Owner occupied spaces shall be cleaned or remedied immediately by the responsible trade. Clean up all surfaces, remove equipment, salvage and debris, and return in condition suitable for use by the Owner as quickly as possible.

17. Asbestos and asbestos containing materials will not be allowed in this project. Upon completion of the project the Contractor and all Subcontractors shall provide Owner with a letter stating that no asbestos and asbestos containing materials were provided at the projects.

18. All wiring shall be in metallic conduit. Conduit on the roof shall be an absolute minimum.

19. CONTINGENCY ALLOWANCE - To be included in Base Bid (See Bid Form). This allowance is for contingencies and shall only be spent on prior written approval of Owner and Engineer. At the end of the contract, unused contingency allowance shall be returned to the Owner. Contingency allowance (dollars) and other allowances (dollars) may be moved from one allowance to another allowance at the sole discretion of the Owner and Engineer, and without any penalty to the Owner.

20. Cutting and Patching.

    "Cutting and patching" includes cutting into existing construction to provide for the installation or performance of other work and subsequent fitting and patching required to restore surfaces to their original condition.

    "Cutting and patching" is performed for coordination of the work, to uncover work for access or inspection, to obtain samples for testing, to permit alterations to be performed or for other similar purposes.

    Do not cut structural members.

21. Schedule, Reports, Meetings, and Payments.

    Contractor shall provide and keep current a construction schedule.

    Contractor shall prepare a schedule of values on AIA forms. Payment schedule may be submitted no more than one per month.

After completion date, no partial payments will be made until all work is one-hundred percent complete and accepted by Engineer and Owner.

22. Temporary construction and support facilities required for the project include but are not limited to the following:

Sanitary facilities (school facilities shall not be used by contractor personnel)
Drinking water
Temporary enclosures and barricades as required
First aid station
Project identification, bulletin boards and all required local, state and federal signs
Waste disposal services
Rodent and pest control
Construction aids and miscellaneous general services and facilities
All excavation shall be properly filled at the end of each work day.

Security and protection facilities and services for the project include but are not limited to the following:

Temporary fire protection
Barricades, warning signs, lights
Environmental protection
The Contractor shall not use the school telephones.
Any temporary heat required.

Hoists: The Contractor, when required, shall install and operate hoists for proper execution of work. Location of hoists shall be approved by the Owner.

23. Protection of Roof

The Contractor and Subcontractors shall accomplish the work in such a manner so as to protect the roof. The Contractor shall be responsible for any damage to the roof.

24. Protection of Carpet, Other Floor Coverings, Lockers, All Surfaces of School, School Equipment & School Property

25. Protect the building and contents (security, rain, etc.) at all times. Provide all materials and labor.

The Contractor shall protect all school surfaces, school equipment, and school property. Any damage shall be repaired or replaced. Contractor shall also protect from scratches. Contractor shall protect carpet, other floor coverings, lockers, all surfaces, all school equipment and all school property. Contractor shall instruct all employees and subcontractors to protect the school. Any ceilings or ceiling tiles damaged shall be replaced with identical.

26. <u>The Contractor shall be responsible for and insure that the mechanical equipment, controls, and electrical work are fully compatible and coordinated.</u>

27. Quality Control & Workmanship

Maintain quality control and supervision over subcontractors, suppliers, manufacturers, products, services, site conditions, and workmanship to produce work of specified quality. Perform all work to the level of quality by Standards in individual Specification Section. All work may be inspected by the Engineer and Owner's Representative for compliance with approved submittals and level of quality specified. The Work, or any part of the Work, deemed unsuitable or below the required level quality by the Engineer or Director of Maintenance shall be replaced or repaired by the Contractor at no additional cost to the Owner.

Comply with industry standards required for high quality commercial and institutional buildings, except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship. Perform work by persons qualified to produce workmanship of specified quality. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibrations, and racking.

28. Fire Protection

The Contractor and Subcontractors shall be responsible for providing temporary fire protection, and accomplishing work in a fire prevention manner. The Contractor shall be solely responsible for means and methods.

29. Telephone

The Contractor shall not make any long distance phone calls on school phones. Use of Owner's telephone is not allowed.

30. Pre-Construction Site Visit With Owner

Prior to start of the work a pre-construction meeting consisting of the Engineer, Owner, Contractor, Subcontractors, and others determined appropriate shall be held to establish basic project understanding and clarify project questions.

Contractor shall make a pre-construction site visit with Owner and note any existing damage in work areas. Contractor shall be responsible for any damage to school property, building, equipment, furnishings, site or school items.

31. All components, devices, and systems shall be U.L. listed.

32. Parking Lots

Prior to starting work, the Contractor shall coordinate with the Owner any work being accomplished on the parking lots. Coordinate scheduling and access. Contractor shall conduct on-site visit with Owner to inspect parking lots and observe all existing conditions. Contractor and subcontractors shall not damage parking lots. Any damage as a result of Contractor or subcontractors shall be repaired or replaced to the Owner's satisfaction and specifications. Coordinate any trenching across parking lots with Owner/Engineer before starting work. Include all pavement, sidewalk, site, etc. repair/replacement work in base bid.

END OF SECTION

SECTION 01 02 00

ALLOWANCES

PART 1 - GENERAL

SUMMARY:

All work accomplished by allowances shall be complete and turn-key.

SECTION INCLUDES:

Include in contractor sum allowances stated in Contract Documents.
Designate in construction progress schedule delivery dates for products specified under each allowance.
Designate in Schedule of Values quantities of materials required under each allowance.

ALLOWANCES FOR PRODUCTS:

Amount of Each Allowance Includes:
- Cost of Product to Contractor or subcontractor, less any applicable trade discounts.
- Delivery to site.
- Labor required under allowance.

In addition to amount of each allowance, include in contract sum Contractor's cost for:
- Handling at site, including unloading, uncrating, and storage.
- Protection from elements and from damage.
- Labor for installation and finishing.
- Other expenses required to complete installation.
- Contractor's and Subcontractor's overhead and profit.

SELECTION OF PRODUCTS UNDER ALLOWANCES:

Engineer's Duties:
- Consult with Contractor in consideration of Products and suppliers or installers.
- Make selection in consultation with Owner. Obtain Owner's written decision, designating:
  - Product, model and finish.
  - Accessories and attachments.
  - Supplier and installer as applicable.
  - Cost to Contractor, delivered to site or installed, as applicable.
  - Manufacturer's Warranties.
- Transmit Owner's decision to Contractor.
- Prepare Change Orders.
- Contractor's Duties:
- Obtain proposals from suppliers and installers when requested by Engineer.
- Make appropriate recommendations for consideration of Engineer.
- Notify Engineer promptly of:
  - Any reasonable objections Contractor may have against any supplier, or party under consideration for installation.
  - Any effect on Construction Schedule anticipated by selections under consideration.

CONTRACTOR RESPONSIBILITY FOR PURCHASE, DELIVERY AND INSTALLATION:

On notification of selection, execute purchase agreement with designated supplier.
Arrange for and process Shop Drawings, Product Data and Samples, as required.
Make arrangements for delivery.
Upon delivery, promptly inspect products for damage or defects.
Submit claims for transportation damage.
Install and finish products in compliance with requirements of referenced specification sections.

ADJUSTMENT OF COSTS:

Should net cost be less than specified amount of allowance, contract sum will be adjusted accordingly by Change Order.

Amount of Change Order will recognize any changes in handling costs at site, labor, installation costs at site, labor, installation costs, overhead, profit and other expenses caused by selection under allowance.

For products specified under unit costs allowance, unit cost shall apply to quantity listed in Schedule of Values.

For products specified under unit allowance, unit cost allowance shall apply to quantities actually used with nominal amount for waste, as determined by receipts, invoices or field measurements.

Submit any claims for anticipated additional costs at site, or other expenses caused by selection under allowance, prior to execution of work.

Submit documentation for actual additional costs at site, or other expenses caused by selection under allowance within 60 days after completion of execution or Work.

Failure to submit claims within designated time will constitute waiver of claims for additional costs.

At contractor closeout, reflect approved changes in contract amounts in final statement of accounting.

CONSTRUCTION CONTINGENCY:

Following shall apply to construction contingency allowance:

It shall be used only to cover cost of hidden, concealed or otherwise unforeseen conditions that develop during project.

Work which is clearly changed in scope shall be authorized and paid for only by means of change order executed in accordance with established procedures.

Bidder shall include in his base bid on project his profit and overhead to cover amount of contingency; as each contingency authorization is processed, it will not include any profit or overhead for Contractor.

Contractor shall proceed with accomplishing work only after receiving properly executed contingency authorization executed by Engineer.

Contractor shall not bill Owner for any work authorized by this procedure until work has been accomplished.

Any part of contingency allowance which is not used during construction of project shall be returned to Owner.

At completion of project, Engineer will reconcile all work accomplished through properly executed contingency allowance authorizations, and provide for refund of any unused portion of contingency to Owner through properly executed change order.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

SCHEDULE OF ALLOWANCES:

Section 01 02 00 - Construction Allowance:

See Bid Form for Allowance.

END OF SECTION

SECTION 02 07 00

SELECTIVE DEMOLITION

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of contract, including General and Supplementary Conditions, Division-1, and Division 0 Specification sections, apply to work of this section.

DESCRIPTION OF WORK:

Extent of selective demolition work is indicated on drawings.

Types of Selective Demolition Work. Demolition requires the selective removal and subsequent off-site disposal in a legal manner of the following items but not limited to:

- Removal of selective piping and items.
- Removal of rooftop units, curbs, ductwork etc. as shown on plans or as required.
- Other items shown on plans, and required for new installation.
- Other items required for installation of work. Replace as required and necessary.
- Other items not needed for new installations.
- Related Work specified elsewhere:

Remodeling construction work and patching is included within the respective sections of specifications, including removal of materials for re-use and incorporated into remodeling or new construction.

Relocation of pipes, conduits, ducts, other mechanical and electrical work are specified by respective trades.

Should any asbestos-containing material be encountered, Contractor shall stop work immediately and contact Owner and Owner's Representative before proceeding with work. The cost of asbestos abatement and removal is not included as part of this contract. The Owner will provide separate Contractors for this work should it be required. However, should the Contractor fail to comply with above stated requirement he will be charged the costs incurred by the Owner for the asbestos clean-up process as a result of the Contractor's actions which disturb any asbestos containing materials. Contact Owner regarding any asbestos information.

SUBMITTALS:

Schedule:

Submit schedule indicating proposed methods and sequence of operations for selective demolition work to Owner's Representative for review prior to commencement of work. Include coordination for shut-off, capping, and continuation of utility services as required, together with details for dust and noise control protection.

Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.

Coordinate with Owner's occupation of portions of existing building.

JOB CONDITIONS:

Occupancy:

Owner may be continuously occupying areas of the building. Conduct selective demolition work in manner that will minimize need for disruption of Owner's normal operations. Provide minimum 72 hours advance notice to Owner of demolition activities which will severely impact Owner's normal operations.

Condition of Structures:

Owner and Engineer assumes no responsibility for actual condition of times or structures to be demolished.

Partial Demolition and Removal:

Items indicated to be removed but of salvable value to Contractor may be removed from structure as work progresses. Transport salvage items from site as they are removed.

Storage and sale of removed items on-site will not be permitted.

Protections:

Provide temporary barricades and other forms of protection as required to protect Owner's personnel and general public from injury due to selective demolition.

Provide protective measures as required to provide free and safe passage of Owner's personnel and general public to and from occupied portions of building.

Erect temporary covered passageways as required by authorize having jurisdiction.

Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse or structure or element to be demolished, and adjacent facilities or work to remain.

Protection from damage existing finish work that is to remain in place and becomes exposed during demolition operations.

Protect floors with suitable coverings when necessary.

Protect all equipment, furnishings and school property.

Construct temporary insulated solid dustproof partitions where required to separate areas where noisy or extensive dirt or dust operations are performed. Equip partitions with dustproof doors and security locks if required.

Provide temporary weather protection design interval demolition and removal of existing construction on exterior surfaces, and installation of new construction to insure that no water leakage or damage occurs to structure or interior areas of existing buildings.

Remove protections at completion of work.

Damages:

Promptly repair damage caused to adjacent facilities by demolition work at no cost to Owner.

Traffic:

Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

Explosives:

Use of explosives will not be permitted.

Utility Services:

Maintain existing utilities keep in service, and protect against damage during demolition operations.

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorized having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.

Environmental Controls:
Comply with governing regulations pertaining to environmental protection.
Do not burn on the site.

PART 3 - EXECUTION

PREPARATION:
Cease operations and notify the Owner's representative immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.

Cover and protect furniture, equipment and fixtures to remain from soiling or damage when demolition work is performed in rooms or areas from which such items have not been removed.

Erect and maintain dust-proof partitions and closures as required to prevent spread of dust or fumes or occupied areas or areas not involved in renovation work.

Provide weatherproof closures for exterior openings from demolition work.

Protection of Roof:
The Contractor and Subcontractors shall accomplish work in such a manner to protect roof. do not roll equipment across roof. Contractor shall be responsible for any damage to roof.

Demolition:
Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.

Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.

Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors or framing.

Provide services for effective air and water pollution controls as required by local, state, and federal authorities having jurisdiction.

If unanticipated mechanical, electrical or structural elements which conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to Owner's Representative in written accurate detail. Pending receipt of directive from Owner's Representative rearrange selective demolition schedule as necessary to continue overall job progress without delay.

Disposal of Demolition Materials:
Remove debris, rubbish and other materials resulting from demolition operations from building site. Transport and legally dispose of materials off site.

If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws and ordinances concerning removal, handling and protection against exposure or environmental pollution. If asbestos is encountered, do not disturb. Contact Engineer and Owner.

Burning of removed materials is not permitted on project site.

Refrigerants shall not be released to the environment.

Clean-Up and Repair:

Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protections and leave interior areas broom clean.

Repair demolition performed in excess of that required. Return structures and surfaces to remain to condition existing prior to commencement of selective demolition work. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

END OF SECTION

PLUMBING

DIVISION 22

22 00 10 Basic Plumbing Requirements
22 00 90 Plumbing Submittal Procedures
22 05 24 Valves General
22 05 30 Pipe and Pipe Fittings General
22 05 54 Plumbing Identification
22 07 20 Piping Insulation
22 13 18 Condensate Piping
22 16 01 Natural Gas Piping and Appurtenances

SECTION 22 00 10

BASIC PLUMBING REQUIREMENTS

PART 1 GENERAL

1.1 DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

A. Basic plumbing requirements necessary to provide complete installation of all Division 22 work.

1.3 WORK INCLUDED

A. This section of work comprises furnishing of all materials, equipment, tools, scaffolding, rigging, hoisting, labor and transportation necessary for the complete installation of the plumbing systems as shown on the plans and as specified herein.

B. Bidders shall determine the contents of a complete set of drawings and specifications and be aware that they may be bidding from a partial set of drawings, applicable only to the various separate contracts, subcontracts, or trades as may be issued for bidding purposes only. The contract documents and the complete scope of work for the project are illustrated on the combined Structural, Mechanical, Heating, Ventilating, Air Conditioning, Plumbing and Electrical, and each Bidder shall thoroughly acquaint himself with all the details of the complete set of drawings and specifications before submitting his bid.

C. All drawings and specifications form a part of the contract documents for each separate contract and shall be considered as bound therewith in the event partial sets of plans and specifications are issued for bidding only. The submission of bids shall be deemed evidence of the review and examination of all drawings, specifications, and addenda issued for this project as no allowances will be made because of unfamiliarity with any portion of the complete set of documents.

D. Plumbing Contractor is responsible for all final connections to specified plumbing fixtures and all owner furnished equipment requiring plumbing (drain, water, gas, condensate, air).

1.4 RELATED SECTIONS

A. The conditions of the Division 01 requirements and the contract requirements which include the General Conditions and the Supplementary Conditions apply to the work of this division.

1.5 CODES & REFERENCE STANDARDS

A. General
   1. Perform all Division 22 work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are modified by the contract documents.
   2. Nothing in the Contract Documents shall be construed to permit work not conforming to these codes.
   3. When two or more codes or standards are applicable to the same work, then the stricter code or standard shall govern.

4. The date of the code or standard that is in effect on the date of issue of the contract documents except when a particular publication date is specified.
5. The Contractor shall be held responsible for verifying all local codes and ordinances that may alter any part of the plans or specifications. The Contractor shall bear all costs for correcting the deficiencies.
6. Where local codes and ordinances are not in writing or on record but a local precedence has been set, the Owner shall pay for any additional cost incurred.

1.6 APPLICABLE CODES AND STANDARDS FOR ALL DIVISIONS 22 WORK

A. International Building Code

B. International Gas Code

C. International Plumbing Code

D. International Mechanical Code

E. Uniform Plumbing Code

F. Uniform Mechanical Code

G. International Energy Conservation Code

H. National Electrical Code

I. American Society of Heating, Refrigerating and Air Conditioning Engineers Standards.

J. Occupational Safety and Health Administration Standards:
   1. OSHA Standard 2207 - Construction Industry Standards
   2. OSHA 29 CFR Part 1926 - Regulation of Excavation
   3. Texas Underground Facility Damage Prevention Act (H.B. 2295)
   4. All other applicable standards

K. National Fire Protection Association:
   1. NFPA No. 90A Installation of Air Conditioning and Ventilating Systems

L. Fire Sprinkler System:
   1. NFPA 13
   2. NFPA 14
   3. NFPA Life Safety Code 101 Section 8-3
   4. All other applicable codes

M. National Appliance Energy Conservation Act of 1987

N. Texas State Board of Insurance Standards

O. Clean Air Act and Clean Air Act Amendments of 1990

P. State Codes:
   1. Texas Department of Labor Boiler Rules and Regulations
   2. All other applicable codes

Q. Local Municipal Codes and Ordinances

R. Schedule of Abbreviations:

1. Reference Standards are listed in Division 22 using abbreviations listed below:

AABC	Associated Air Balance Council
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
AGA	American Gas Association
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
AWE	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
CS	Commercial Standard
CSA	Canadian Standards Association
DIPRA	Ductile Iron Pipe Research Association
DOT	Department of Transportation
DOC	Department of Commerce
FCC	Federal Communications Commission
FM	Factory Mutual
FS	Federal Specification
IBC	International Building Code
ITL	Independent Testing Laboratories
NEC	National Electric Code
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning National Association
TDH	Texas Department of Health
TWC	Texas Water Commission
UL	Underwriters Laboratories

1.7 QUALITY ASSURANCE

A. Provide complete installations of all systems.

B. Furnish all items of equipment, material, and labor to complete the Contract even though each and every item necessary is not specifically mentioned or shown.

C. In case of any conflict between the specifications, plans and ordinances, the ordinances shall govern.

D. All materials furnished under this Contract shall be new, free from defects of any kind, of the quality and design hereinafter specified, and shall conform to the standards of Underwriter's Laboratories Inc., except for equipment which U.L. does not list or provide label service.

E. All plumbing equipment and fixtures shall be the same brand unless scheduled differently on plans.

1.8 CONTRACTOR'S RESPONSIBILITY

A. Erect barricades, protective fencing, and signs to prevent injury to personnel on site.

B. Make permanent connection to utilities or existing lines. Determine depth and location, and bid accordingly.

C. Relocate and repair any existing lines cut by general construction work.

D. Pay all costs in connection with metering devices.

E. Plans do not show exact location and elevations of lines, nor do they show all offsets required.

F. Deviate from plans as required to conform to the general construction and provide proper grading.

G. Maintain all utility services during construction to existing portions of job that remain.

H. Procure and pay for all necessary permits or licenses to carry out the work.

I. Obtain and pay for all the necessary certificates of approval which must be delivered to the Engineer before final acceptance of the work.

J. Periodically remove rubbish, clean or repair all surfaces marred by the work required under this contract.

K. Protect work from damage by other trades.

L. Make all tests required by law; pay all costs in connection with the testing.

M. Where job conditions require changes in indicated locations and arrangement, make such changes without extra cost to Owner.

N. Provide motor starters, controls, relays, all low-voltage wiring, conduit and wiring related to plumbing and other equipment and devices to form a complete working system. See Division 26 00 00.

1.9 DEFINITIONS

A. Approval:
   1. It is understood that approval must be obtained from the Engineer in writing before proceeding with the proposed work.
   2. Approval by the Engineer of any changes, submitted by the Contractor will be considered as general only to aid the Contractor in expediting his work.

B. Contractor:
   1. The Contractor engaged to execute the work included in a particular section only, even though he may be technically described as a Subcontractor to the General Contractor.
   2. If the Contractor engaged to execute said work employs Sub-Contractors to perform various portions of the work included under this Section, he shall be held responsible for the execution of same, in full conformity with Contract Document requirements.
   3. The Contractor shall cooperate at all times and shall be responsible for the satisfactory cooperation of his Subcontractors with the other Contractors on the job so that all of the various phases of the work may be properly coordinated without unnecessary delays or damage to any parts of the work of any Contractor.

C. Provide:
   1. Defined as requiring the furnishing and installing of the item or facility indicated, complete in all respects and ready for operation unless otherwise specifically noted.

1.10 WARRANTY

A. The Contractor shall warranty his work against defective materials and workmanship for a period of one year from date of acceptance of the job.

B. Neither the final payment nor any provisions in Contract Documents shall relieve the Contractor of the responsibility for faulty materials or workmanship.

C. He shall remedy any defects due thereto and pay for any damage to other work resulting therefrom, which shall appear within a period of one year from date of substantial completion.

D. The Owner shall give notice of observed defects with reasonable promptness.

E. This Guarantee shall not be construed to include the normal maintenance of the various components of the system covered by these specifications.

1.11 SITE VISIT

A. Before submitting his proposal, each bidder shall examine all plans and specifications relating to the work, shall visit the site of the project and become fully informed of the extent and character of the work required.

B. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or the amount of work to be done, it being fully understood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein, or indicated on the accompanying plans or required by nature of the site of which may be fairly implied as essential to the execution and completion of any and all parts of the work.

1.12 PROJECT RECORD DOCUMENTS

A. The Contractor shall keep a set of plans on the job, noting daily all changes made in connection with the final installation including exact dimensioned locations of all new and uncovered existing utility piping outside the building.

B. Upon submitting his request for final payment, he shall turn over to the Engineer, for subsequent transmittal to the Owner, a clean, neatly marked set of reproducible plans showing "as installed" work and an electronic file with changes of materials.

C. In addition to the above, the Contractor shall accumulate during the job's progress the following data, in duplication (2 each), prepared in 3 ring binders of sufficient size, black in color, neat in appearance, and turned over to the Engineer for checking and subsequent delivery to the Owner:
   1. All warranties, guarantees and manufacturer's directions on equipment and material covered by the Contract.
   2. Approved fixture brochures.
   3. Copies of reviewed shop drawings.
   4. Set of operating instructions. Operating instructions shall also include recommended maintenance.
   5. Any and all other data and/or plans required during construction.
   6. Repair parts lists of all major items and equipment including name, address and telephone number of local supplier or agent.
   7. The first page, or pages, shall have the names, addresses, and telephone numbers of the following:
      a. General Contractor and all sub-contractors.
      b. Major Equipment Suppliers.

1.13 TRAINING

A. Upon completion of the work and at a time designated by the Owner's representative, provide a formal training session for the Owner's operating personnel to include location, operation, and maintenance of all plumbing equipment and systems, some sections have further instructions.

B. Before proceeding with instruction, prepare a typed outline in triplicate listing the subjects that will be covered. Submit the outline for review by the Owner's representative.

C. At the conclusion of the instruction, obtain the signatures of the attendees on each copy of the outline to signify that they have a proper understanding of the operation and maintenance of the system. Submit the signed outlines to the Owner's representative and Engineer as a condition of final acceptance.

1.14 PLANS AND SPECIFICATIONS

A. The plans show diagrammatically the locations of the various lines, ducts, conduits, fixtures, and equipment and the method of connecting and controlling them.

B. It is not intended to show every connection in detail and all fittings required for a complete system.

C. The systems shall include but are not limited to the items shown on the plans.

D. Exact locations of these items shall be determined by reference to the general plans and measurements of the building and in cooperation with other Contractors, and in all cases, shall be subject to the approval of the Engineer.

E. The Engineer reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.

F. Contractor, subcontractor, vendors and suppliers are required to waive subrogation against Owner and Engineer.

1.15 UTILITIES, LOCATIONS, AND ELEVATIONS

A. Locations and elevations of the various utilities within the scope of this work have been obtained from the City and/or other substantially reliable sources and are offered separately from the Contract documents, as a general guide only, without guarantees as to accuracy.

B. The Contractor shall examine the site, shall verify to his own satisfaction the locations, elevations and availability of all utilities and services required, and shall adequately inform himself as to their relation to the work; the submission of bids shall be deemed evidence thereof.

C. The Contractor shall coordinate all services with the Utility Companies during construction, coordinate changes made by Utility Companies to the design of project, and coordinate with the Owner, Engineer, and Utility the scheduling of any shutdowns or delays that may occur in providing service.

D. The Contractor shall verify location, conduct all necessary tests, inspections, coordinate with Owner's representatives and utilities, and check for existing underground utilities and lines before ditching.

E. The Contractor shall be responsible for repair of any cut or damaged lines or utilities he uncovers. There are lines and utilities not shown on any plans.

F. Contractor is responsible for coordination of all existing and new utilities at site. Contractor is responsible for protecting and repairing any utilities damaged by installation of pipe. All existing and new landscaping/trees to remain and to be protected unless directed otherwise by Owner.

1.16 SUBSTITUTION OF PRODUCTS

A. Substitution of products specified herein will be considered only when a complete list of proposed alternative equipment is submitted to the Engineer in writing, supported by adequate technical and cost data. This includes a complete description of the proposed substitution, drawings, catalog cuts, performance data, test data, or any other data or information necessary for evaluation.

B. All proposed substitutions and data must be received by the Engineer no less than ten working days prior to the schedule date for opening of bids.

C. The Engineer will consider all such submittals and the Engineer will issue an addendum listing items which the Engineer considers acceptable. Only such items as specified or approved as acceptable will be installed on this project.

D. Manufacturers' names are listed herein and on the plans to establish a standard of quality and design. Where a manufacturer's name is mentioned, products of other manufacturers will be acceptable, if in the opinion of the Engineer, the substitute material is of equivalent quality or better than that of the material specified.

E. The Contractor's Bid represents that the bid price is based solely upon the materials and equipment described in the Bid Documents (including addenda, if any) and that he contemplates no substitutions or extras.

F. Requests for substitution are understood to mean that the Contractor:
   1. Has personally investigated the proposed substitution and determined that it is equal or superior in all respects to that specified.
   2. Will provide the same guarantee for the substitution that he would for that specified.
   3. Will, at no cost to the Owner, replace the substitute item with the specified product if the substitute item fails to perform satisfactorily.

G. After Award of the Contract, substitutions will be considered only under one or more of the following circumstances:
   1. The substitution is required for compliance with subsequent interpretations of code or insurance requirements.
   2. The specified product is unavailable through no fault of the Contractor.
   3. The manufacturer refuses to warranty the specified products as required.
   4. Subsequent information that the specified product is unable to perform properly or to fit in the designated space.
   5. In the Engineer's sole judgment, the substitution would be in the Owner's best interest.

H. Revisions to the plumbing system shall be under the supervision of the Engineer at a standard hourly rate charged by the Engineer and shall be paid by the Contractor originating the changes.

1.17 PROTECTION OF EQUIPMENT AND MATERIALS

A. The Contractor shall take such precautions as may be necessary to properly protect his apparatus from damage.

B. This shall include the creation of all required temporary shelters to adequately protect any apparatus above the floor of the construction and the covering of apparatus in the completed building with tarpaulins or other protective covering.

C. Failure to comply with the above to the satisfaction of the Owner's inspector will be sufficient cause for the rejection of the equipment in question and its complete replacement by this Contractor.

D. All apparatus shall be cribbed up from the floor or ground by the Contractor and covered with tarpaulins or other protective covering where necessary or directed.

1.18 FINAL INSPECTION

A. It shall be the duty of this Contractor to make a careful inspection trip of the entire project, assuring himself that the work on the project is ready for final acceptance before calling upon the Engineer to make a final inspection.

B. To avoid delay of final acceptance of the work, the Contractor shall have all necessary bonds, warranties, receipts, affidavits, etc., called for in the various articles of these specifications, prepared and signed in advance, together with a letter of transmittal, listing each paper included, and shall deliver the same to the Engineer at or before the time of said final inspection. The Contractor is cautioned to check over each bond, receipt, etc., before preparing for submission to verify that the terms check with the requirements of the specifications.

1.19 CUTTING AND PATCHING

A. All Subcontractors shall notify the General Contractor sufficiently ahead of construction of any floors, walls, ceiling, roof, etc., of any openings that will be required for his work.

B. He shall see that all sleeves required for his work are set at proper times so as to avoid delay of the job.

C. All necessary cutting of walls, floors, partitions, ceilings, etc., as required for the proper installation of the work under this Contract shall be done at the Subcontractor's expense in a neat and workmanlike manner, and as approved by the Engineer.

D. No joists, beams, girders or columns shall be cut by any Contractor without first obtaining written permission of the Engineer.

E. Patching of openings and/or alterations shall be provided by the General Contractor.

F. All openings in firewalls and floors, such as thimbles, shall be completely sealed after installation for a completely airtight and watertight installation. Sealing material shall be non-combustible and UL approved. The installed sealing assembly shall not cause the fire rating of the penetrated structure to be decreased.

G. All openings in exterior walls shall be sealed watertight.

1.20 IDENTIFICATION

A. Refer to Section 22 05 54.

1.21 MANUFACTURER'S INSTRUCTIONS

A. All equipment and devices shall be installed in accordance with these plans and specifications, manufacturer's instructions and applicable codes.

B. Where specifications call for installation of a product to be in accordance with manufacturer's instructions and/or where manufacturer's instructions are required for installation of a product, it shall be the Contractor's responsibility to obtain the necessary applicable manufacturer's instructions and install the product in accordance with the manufacturer's instructions.

C. It shall be the Contractor's responsibility to install all equipment, materials, and devices shown on the plans and as called out in these specifications even if manufacturer's instructions are absolutely unattainable.

1.22 RELATED WORK

A. The various specification sections for this division may or may not include related work listings.

B. All related work shall be coordinated and provided by the Contractor regardless whether specifically identified or not.

1.23 ELECTRICAL WIRING AND EQUIPMENT FOR PLUMBING SYSTEMS

A. All wiring, conduit, boxes, equipment (controls, thermostats, relays, contactors, motor starters, heaters, switches) and any other control devices or equipment required to form a complete and properly operating system, shall be the responsibility of this Contractor.

B. The Electrical Contractor shall only provide line voltage (including hook-up) to all plumbing equipment.

C. All controls and devices shall be low voltage unless otherwise noted or shown on the plans. Where line voltage controls or devices are noted, the Contractor shall provide complete wiring diagrams (approved by the Engineer) to the Electrical Contractor prior to final hook-up.

D. The Plumbing and Electrical plans are based on the equipment and devices scheduled as shown on the plans or as called for in the specifications. Should any plumbing equipment or device be changed or approved from those which are shown or noted, all electrical and/or plumbing changes shall be made at the expense of the trade or Contractor initiating the change with no expense to the Owner, Engineer or their representatives.

E. All wiring provided by this Contractor shall be installed in a workmanlike manner using tie wraps, labels, anchors and etc. Loose wiring is not acceptable.

F. All conduit and boxes required in all walls for control purposes (thermostats, switches, etc.) shall be provided by electrical contractor.

G. All conduit required in attic, clear spaces, or on roof shall be by electrical Contractor.

1.24 DEMOLITION AND REMODEL

A. It shall be the responsibility of this Contractor to see that all demolition and remodeling work involving his trade (including but not limited to plumbing piping, condensate lines, plumbing equipment, etc.) is accomplished in a manner and completeness to provide the appearance of new construction work.

B. Abandoned plumbing fixtures shall be removed and disposed of off-site in a legal manner.

C. Any usable equipment and/or structure damaged during demolition and remodel work shall be replaced.

D. All abandoned and/or otherwise unused piping shall be securely capped using materials of the same composition as the original piping.

E. No exposed piping and/or other materials will be permitted in the finished job.

F. Any abandoned piping which penetrates the slab in an exposed area shall be sealed and securely capped below the slab.

1.25 OPERATION PRIOR TO COMPLETION

A. When any piece of plumbing equipment is operable and the Contractor needs to operate the equipment, he may do so providing that he properly supervises the operation.

B. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner.

C. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all punch list items before final acceptance by the Owner.

D. The date of acceptance and the start of the warranty may not be the same date.

1.26 SAFETY GUARDS

A. Contractor shall furnish and install all safety guards required. All belt driven equipment, projecting shafts and other rotating parts shall be enclosed or adequately guarded.

1.27 FLAME SPREAD PROPERTIES OF MATERIALS

A. All materials and adhesives used for plumbing and insulation shall conform to NFPA and UL life and flame spread properties of materials.

B. The composite classifications shall not exceed 25 for a flame spread rating and 50 for a smoke developed rating as listed for the basic material, the finishes, adhesives, etc., specified for each system and shall be such when completely assembled.

1.28 ASBESTOS

A. No asbestos or asbestos containing materials shall be permitted in this project.

1.29 LEAD MATERIALS

A. No lead or lead containing materials shall be allowed in any domestic or potable water supply piping, valves, fixtures, components, equipment or any other item.

1.30 REFRIGERANTS

A. Chlorofluorocarbons (CFCs) shall not be allowed in any equipment on this project.

B. Comply with ASHRAE Standards 15 and 34.

1.31 REFRIGERANT RECOVERY AND RECYCLE

A. Refrigerants shall not be released to the environment.

B. Contractor shall provide recovery and recycle equipment that has been certified by the Electrical Testing Laboratories or Underwriters Laboratories.

C. Contractor shall also provide properly trained and certified (in accordance with EPA) personnel for refrigerant work during installation, demolition, start-up, servicing, etc.

1.32 ACCESS CLEARANCE

A. Proper access to all installed equipment shall be provided. This Contractor shall label all points of access immediately upon installation with a marker pen.

B. A minimum of 3 feet shall be maintained in front of all access points.

C. If another trade violates this space, this Contractor shall immediately notify the General Contractor to correct this condition.

D. When equipment is installed above lay-in ceiling this Contractor shall coordinate with the Ceiling Contractor to provide access without removing part of T-bar ceiling.

E. No speakers, lights, fire alarm equipment, etc. shall be installed in lay-in ceiling tiles where access is to be gained.

PART 2 PRODUCTS

A. Not Applicable

PART 3 EXECUTION

3.1 TESTING

A. After all plumbing systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation regardless of the season the Contractor shall test all plumbing equipment.

B. Perform a smoke test on all sanitary sewers and camera all lines and provide owner with a video tape.

C. Perform gas piping pressure test to comply with HB 1611 and all required City or governing body tests.

D. Make adjustments as required to ensure proper functioning of all systems.

E. Special tests on individual systems are specified under individual sections.

3.2 AS BUILT DRAWINGS

A. Upon substantial completion, Contractor shall submit as built drawings showing all deviations between contract drawings and actual installed conditions.

B. Show location of all valves in gas and water piping. Submit to Owner.

END OF SECTION

SECTION 22 00 90

PLUMBING SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This section supplements Division 01 Submittal Procedures and contains additional requirements applicable to Division 22 submittals.

1.2 SECTION INCLUDES

A. This section includes, but is not limited to:
   1. Plumbing submittal procedures
   2. List of required Division 22 submittals to the engineer
   3. This section applies only to the Division 22 specifications. Submittals required by other specification divisions are not included here, even though the same subcontractor may be providing work under other divisions.

1.3 RELATED SECTION

A. Division 01 - Submittal Procedures

1.4 DEFINITIONS

A. Product Data: Illustrations, standard schedules, performance charts, instructions, and brochures furnished by the contractor, subcontractor, manufacturer, or supplier to illustrate materials or equipment or to illustrate some portion of the work. Provide a summary of scheduled items with all data in schedules.

B. Shop Drawings: Drawings, diagrams, schedules and other data specifically prepared for the work by the contractor, subcontractor, manufacturer, or supplier to illustrate some portion of the work.

C. Equipment/Material Submittal Package: A compilation of the product data, shop drawings, and other items as required by the specifications, submitted near the start of the work. Typically, the specifications require the initial submittal package to be submitted within a certain number of days after the work starts.

D. Quality Assurance Submittal: Items submitted before and during the execution of a particular portion of the work for the purpose of guarding against defects and deficiencies.

E. Quality Control Submittal: Items submitted at the completion of a particular portion of the work for the purpose of evaluating completed activities and elements of the work for conformance with contract requirements (e.g. start-up reports).

F. Closeout Submittals: Items submitted at or near the completion of the contract.

1.5 SUBMITTALS

A. The materials, workmanship, design, and arrangement of all work installed under this contract shall be subject to the review of the architect, engineer and owner.

B. Manufacturers: Manufacturers submitted shall be as per the acceptable manufacturers listed in each specification section or referenced schedule. For additional manufacturers requiring approval, reference the Substitution of Products article in Section 22 00 10.

C. Required Submittals: Refer to the Submittals article of each individual Division 22 specification section for the required items to be submitted.

D. Contractor's Coordination Submittals: The contractor may require his subcontractors to provide drawings, setting diagrams, and similar information to help coordinate the project, but such data shall remain between the contractor and his subcontractors and will not be reviewed by the engineer.

E. Electronic Submittals: E-mail or other electronic forms of submittals from the contractor are required. The procedures described in this section shall be as follows:
   1. The contractor shall supply one electronic copy of the submittal.
   2. The electronic files will either be e-mailed to the architect, or posted to a project management and information exchange web site, depending on the architect's requirements. The architect and contractor can distribute copies of the files as desired.
   3. The engineer will retain an electronic copy of the submittal and all responses.

F. Coordination Correspondence: The contractor may desire to verify the acceptability of a particular item prior to assembling the initial submittal package. The contractor may send material directly to the engineer for comments and feedback. This communication will be treated as normal coordination correspondence and will not be tracked or documented as a formal submittal. The engineer may or may not respond to such correspondence. If the engineer agrees, in writing, to the use of a particular item, then that same material shall be included in the initial submittal package along with a copy of the correspondence.

G. Unapproved Products: If materials or equipment are installed before being reviewed and approved by the engineer, the contractor shall be liable for the removal and replacement of such unapproved materials and equipment, at no additional expense to the owner. Additionally, if the removal and replacement of unapproved materials or equipment necessitates the removal and replacement of other related materials or equipment, then the contractor shall be liable for the removal and replacement of the related materials and equipment at no additional expense to the owner.

H. Product Data:
   1. Where the content of manufacturer submittal literature includes data not pertinent to the submittal, clearly indicate which portions of the contents are being submitted for review. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested shall be specific and identifications in catalog, pamphlets, etc., of items submitted shall be clearly made in a contrasting ink or highlighting. Data of a general nature shall not be acceptable.

I. Shop Drawings:
   1. Scale and measurements: Make shop drawings accurately to a scale sufficiently large to show all pertinent aspects of the item.
   2. Electronic shop drawing submittals are required.
   3. Shop drawings must include domestic water entry rooms with backflow prevention and all water heater rooms.

1.6 QUALITY ASSURANCE / CONTROL SUBMITTALS

A. Quality assurance and quality control submittals may be in the form of documentation, or may be in the form of completed physical work that is offered for review by the engineer, architect, or owner.

B. If documentation is the subject, then submit in a manner similar to the initial submittal package.

C. If completed physical work is the subject, then the work shall not be concealed, nor shall subsequent work be performed, until the engineer's representative has reviewed the work. If the work is concealed, or if subsequent work is performed, before the engineer's representative has reviewed the work, then the contractor shall be liable for removal and replacement at no additional expense to the owner.

D. Sequencing:
   1. Within 30 calendar days after the contractor has received the owner's notice to proceed, provide the complete submittal package.
   2. After the engineer has reviewed the submittal package, make necessary revisions to the submittals as directed by the engineer and resubmit.
   3. After the submittal has been reviewed by the engineer, proceed to purchase materials and perform the work.

E. Scheduling:
   1. Failure to submit items that meet the requirements of the contract documents in ample time for review shall not entitle the contractor to an extension of contract time, and no claim for extension by reason of such default shall be allowed. The contractor may be held liable for delays so occasioned.

PART 2 PRODUCTS

A. Not applicable

PART 3 EXECUTION

3.1 SUBMITTALS

A. Make submittals of product data, shop drawings, samples, quality assurance submittals, quality control submittals, and other items in accordance with the requirements of this section, applicable sections in Division 22, and additional requirements of each individual Division 22 specification section.

B. Grouping of Submittals:
   1. The submittal package shall be coordinated and included in a single submission. Multiple submissions are not acceptable except where prior written approval has been obtained from the engineer. Partial submittals may be rejected, without being reviewed, as not complying with the provisions of the contract.
   2. In the case that multiple submissions are approved, it is the responsibility of the contractor to maintain and update a submittal check list. The contractor shall ensure that all applicable submittal sections are submitted to the Engineer. If a submittal section is not submitted, it will be considered rejected until reviewed by the Engineer.
   3. If submittal sections are submitted as individual submittal files, the submittal sections will be grouped and returned as one file with one set of submittal responses.

C. Electronic Submittal Organization:
   1. Electronic submittals are to be submitted as a single PDF file. Within the PDF file, each section shall be bookmarked.
   2. Provide an electronic submittal cover sheet that lists at least the following:
      a. Project name
      b. Date
      c. Name and address of architect

d. Name and address of engineer
e. Name, address and telephone number of prime contractor
f. Name, address and telephone number of HVAC contractor
g. Name, address and telephone number of HVAC supplier

3. Provide an electronic index sheet listing all items submitted.
4. The contractor shall call to the attention of the engineer, clouded in the submittal and noted after the index sheet, any instance in which the submittals are known to differ from the requirements of the contract documents.
5. Organize all required items by specification section. The material for each specification section shall be organized as follows:
   a. Provide an electronic section cover sheet that lists the same information as the submittal cover sheet, plus the specification number and title and the name, address and telephone number of the vendor or vendor's representative, if applicable.
   b. Refer to the individual Division 22 specification sections for any required organization of the submittal material within each submittal section.
   c. Bookmarked sections shall be arranged by specification section number in numerical order.
   d. Submit in accordance with these procedures and procedures described in Division 01 Submittal Procedures.
   e. Submittals not organized as described here may be rejected, without being reviewed, as not complying with the provisions of the contract.

D. Response to engineer's review:
1. Review comments:
   a. Review comments of the engineer will either be shown on the returned sets to the contractor, or shown on a document attached to the sets. If the comments are on an attached document, then the engineer will place a note on the submittal referring to the attached comments. In such cases, the engineer's signature will appear only on the attached document. If the attached, signed document becomes physically separated from the submittal, then the submittal will no longer be considered as being a reviewed submittal.
2. Complete rejection:
   a. If the submittal is not complete or does not meet the requirements of this specification section, then the engineer may reject the entire submittal and return the submittal without further review or comment. In such cases, the entire submittal shall be completely revised and resubmitted. The resubmittal shall be given a new submittal number and shall be documented and processed as a separate submittal from the original.
3. Held for completion:
   a. If the submittal is not complete, but is only missing some minor item, the engineer may, at the engineer's sole discretion, hold the submittal rather than rejecting and returning the submittal. In such cases, the engineer will notify the architect and contractor that the submittal is being held for completion. The contractor will be given a predetermined amount of time to provide the missing item. Upon receipt of the missing item, the engineer will insert the missing item into the submittal package and proceed with the review process.
4. Partial rejection:
   a. The engineer may reject only certain portions of the submittal. In such cases, only those rejected portions or items need to be revised and resubmitted.

5. Provide as corrected:
    a. The engineer may note a required change to a submitted item, but may not consider the change serious enough to require a resubmittal. In such cases, the engineer will note that the item is to be provided as noted or corrected. In such cases, the contractor may proceed to provide the item. However, if subsequent observations reveal that the noted change was not made, then the contractor shall be liable for removal and replacement of the item at no additional cost to the owner.
6. Reviewed without comment:
    a. The contractor may proceed to provide all materials and equipment.

E. Close-out Submittals:
1. Provide close-out submittals in accordance with the requirements of Division 1.

Section	Submit on the following	1	2	3	4	Arch Sub #
22 05 24	**Valves**					
	Full port					
	Bronzed body					
	Ball valves					
22 05 30	**Pipe and Pipe Fittings**					
	Hangers					
	Dissimilar Metals Union					
	Unions					
	Escutcheons					
	Sleeves					
	Hanger rods					
	Concrete anchors					
	Beam Clamps					
	Fire Penetration Products					
22 05 54	**Plumbing Identification**					
	Valve tags and chains					
	Valve chart					
	Piping markers					
	18 gauge copper wire for underground gas piping					
	Equipment labels					
	Nametag fasteners					
	Underground warning tape					
22 07 20	**Piping Insulation**					
	Closed cell only in concrete masonry walls					
	2” wrap for concealed roof drain piping					
	2” wrap at roof drain deck pan					
	2” rigid on exposed roof drains or					
	2” wrap with PVC jacketing on exposed roof drains					
	Domestic hot and cold water pipe insulation					
	(1” for hot water and 1” for lines in exterior walls)					
	Flange, fitting, valve Insulation					
	Insulation metal shield					
	Sealant, adhesive, finish					
22 13 18	**Condensate Piping**					
	Copper type M or DWV					
	Insulation thickness and thermal conductivity (K)					
	Hangers- see 22 05 30					
	Insulation-See piping insulation					
	Fittings, unions					
22 16 01	**Natural Gas Piping and Appurtenances**					

Section	Submit on the following	1	2	3	4	Arch Sub #
	Schedule 40 black steel pipe and fittings					
	Gas regulators					
	Paint for roof and up wall installations					
	Cut off valves, unions, inspection ports					
	Polyethylene gas piping below grade					
	Roof supports					

1 - Reviewed
2 - Furnish as corrected in comments, resubmit not required
3 - Revise and Resubmit based on comments
4 - Rejected based on comments

END OF SECTION

SECTION 22 05 24

VALVES - GENERAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

A. General requirements for valves

1.3 RELATED SECTIONS

A. Section 22 00 10 - Basic Plumbing Requirements

B. Section 22 05 30 - Pipe and Pipe Fittings - General

C. Section 22 16 01 - Natural Gas Piping and Appurtenances

1.4 REFERENCES

A. ASTM 763 - Standard Specification for Copper Alloy Sand Castings for Valve Applications

B. ASTM 61 - Standard Specification For Steam or Valve Bronze Castings

C. ASTM C27450 - Standard Specification for Brass Rod, Bar & Shapes

D. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges & Pipe Fittings

E. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications

F. ASTM - American Society of Testing Materials

G. ASTM A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service

H. ASTM B813-00e1 - Standard Specification for Liquid & Paste Fluxes for Soldering of Copper & Copper Alloy Tube

I. ASTM B828-02 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings

J. ASTM B88-02 - Standard Specification for Seamless Copper Water Tube

K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings

L. CSA - Canadian Standards Association

M. PDI - Plumbing & Drainage Institute

1.5 QUALITY ASSURANCE

A. Manufacturer to stamp valve to show that shell and seat tests have been successfully completed.

1.6 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.

PART 2 PRODUCTS

2.1 MATERIAL SPECIFICATIONS

A. Bronze - 150 psi maximum: ASTM B62

B. Bronze - 300 psi maximum: ASTM B61

C. Cast Iron: ASTM A126, Class B

D. Cast Carbon Steel: ASTM A216, Grade WCB

E. Forged Carbon Steel: ASTM A105, Grade II

F. Brass - Lead free, dezincification resistant arsenical brass, 125 psi maximum, ASTM 763 or B283.

2.2 CONSTRUCTION

A. Provide valves designed for repacking under pressure when fully opened.

B. Equip with packing suitable for intended service.

C. Furnish with gland followers.

D. Provide valves rated greater than the design temperature and pressure for the intended system.

E. All domestic cold water and hot water valves 2" and less shall be full port ball valves with stainless steel ball.

F. All domestic cold water and hot water valves 2-1/2” and larger to gate valves.

2.3 MANUFACTURERS

A. Apollo

B. Crane

C. Grinnell

D. Jenkins

E. Jomar, T-100NGDZ

F. Kennedy

G. Milwaukee Valve Company

H. Nibco

I. Stockham

J. Walworth

K. Watts

L. Hammond

M. Kitz

PART 3 EXECUTION

3.1 INSTALLATION

A. Install valves and stops in accessible locations.

B. Provide where shown or as required to make system complete and readily maintained.

C. Provide access doors for all inaccessible valves.

D. Provide as built drawings locating all valves in gas and water lines.

END OF SECTION

SECTION 22 05 30

PIPE AND PIPE FITTINGS - GENERAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

A. Pipe

B. Pipe fittings

1.3 RELATED SECTIONS

A. Section 22 00 10 - Basic Plumbing Requirements

B. Section 22 05 24 - Valves - General

C. Section 22 07 20 - Piping Insulation

D. Section 22 13 18 - Condensate Piping

E. Section 22 16 01 - Natural Gas Piping and Appurtenances

1.4 REFERENCES

ASME	American Society of Mechanical Engineers
ASTM C564-97	Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D2665-02a	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM E84-01	Standard Test Method for Surface Burning Characteristics of Building Materials
UL	Underwriters Laboratory
NFPA 90 A & B	Installation of Air Conditioning & Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems
CISPI-310	Cast Iron Soil Pipe Institute
CSA	Canadian Standards Association

1.5 QUALITY ASSURANCE

A. Valves:
   1. All valves to be from a single manufacturer.

B. The welder, employed on this project, shall have passed qualification tests as prescribed by the National Pipe Welding Bureau, or other reputable testing laboratory using qualification procedures as recommended by the ASME Boiler Construction Code or the American Welding Society Standards.

1.6 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.

B. Submit product data indicating dimensions, general assembly and use.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

A. The type of pipe and fittings necessary for each system is specified in the section on that system.

2.2 DISSIMILAR MATERIALS

A. Use approved adapters such as Di-Electric Unions manufactured for making piping connections between dissimilar materials such as copper and brass or copper and steel.

2.3 ESCUTCHEONS

A. Usage:
   1. All exposed lines passing through floors, walls and ceilings.

B. Material:
   1. Chrome plated steel

C. Flange size:
   1. As necessary to cover penetrated openings.

D. Plate size:
   1. As necessary to fit pipe or insulation and securely lock in place.

E. Manufacturer/Model:
   1. Engineered Brass Company, Type CF

2.4 SLEEVES

A. Application:
   1. Provide sleeves for all pipes and conduits which pass through or enter a concrete slab, masonry wall/concrete wall, sheetrock wall (fire rated or not fire rated), roof or other portion of the building structure.

B. Above Grade and/or dry locations:
   1. Material:
      a. 20 or 22 gauge galvanized steel.
   2. Size:
      a. As necessary to allow free passage of the insulated pipe.

C. Below Grade and/or moist locations:
   1. Material:
      a. ASTM D-2665 Schedule 40 PVC. When PVC not allowed by code, use schedule 40 galvanized steel.
      b. Return Air Plenum:
         (1) Schedule 40 galvanized steel.

D. Passing through fire-rated enclosures:
   1. Material:
      a. Galvanized or black steel pipe.
      b. Non-combustible.
      c. PVC will not be allowed.

E. Penetration Seal: (All Sleeved Penetration Locations- fire rated or non-fire rated)
   1. Seal penetration with 3M Fire Barrier Sealant CP 25WB+ or one-component ceramic fiber-based putty fill, void or cavity material, UL rated material classified for use in through-penetration firestop systems nos. 124, 125, 150 and 151.
   2. Flame Spread/Smoke Contribution:
      a. 0/0 in accordance with ASTM E-84.

2.5 VALVES, UNIONS, STOP COCKS, ETC.

A. Applications:
   1. Ball Valves:
      a. Provide accessible valves at each group of plumbing fixtures and at each piece of equipment on all piping systems for isolation of fixtures and equipment. All valves shall be full port valves.

B. All Other Valves, Unions, Stop Cocks, Etc.:
   1. Provide at each group of plumbing fixtures and at each individual fixture, at each piece of equipment, at all inlet and outlet connections for hot and cold water and gas.
   2. Provide Di-Electric Unions at connection of dissimilar pipe materials to prevent electrolysis.

C. Type:
   1. Suitable for 125 lbs. working pressure.

2.6 PIPE SUPPORTS

A. Hangers:
   1. 2" and Smaller Piping:
      a. May be split cast ring type with fastening device in walls and chases.
   2. Copper Piping:
      a. Copper plated ferrous hangers.
   3. All Other Above Ceiling Locations:
      a. Adjustable clevis type. Hangers to accommodate circumference of pipe and saddles.

B. Hanger Rods:
   1. Type:
      a. Minimum 3/8 inch diameter with machine threads.

C. Minimum Steel Hanger Rod Diameter for Individually Suspended Horizontal Pipes:
   1. 2" and smaller diameter pipe:
      a. 3/8"
   2. 2-1/2" to 3 - 1/2" diameter pipe:
      a. 1/2"
   3. 4" to 5" diameter pipe:
      a. 5/8"
   4. 6" diameter pipe or larger:
      a. 3/4"

D. Hanger Manufacturers:
   1. Anvil
   2. Elcen
   3. ERICO
   4. F&S Manufacturing
   5. Fee & Mason
   6. PHD

E. In wall pipe supports:
   1. Metal strut, manufactured pipe clamps

F. In wall pipe support manufacturer:
   1. Holdrite or Equivalent

PART 3 EXECUTION

3.1 PIPE INSTALLATION

A. Install piping in a neat and workmanlike manner.

B. Install each of the piping systems to provide for expansion and contraction.

C. Solder all joints when the system is not under strain.

D. Expansion Offsets:
   1. Copper Piping:
      a. Use developed length Copper Tube Handbook 411-R as published by Copper Development Association, Inc.
   2. Steel Piping:
      a. Use developed per Carrier System Design Manual, Part 3 Piping Design.

E. Furnish necessary spring pieces and offsets as required.

F. Conceal all of the piping systems in chases, above ceilings, in walls and in finished areas.

G. Run Exposed piping only in machinery spaces and unfinished areas as specified or as shown on the plans.

H. Install all necessary fittings and offsets to hold the piping close to walls and ceilings.

I. Where these lines run exposed, obtain a clearance from the Engineer in writing before making the installation.

J. Install piping in the most advantageous manner possible with respect to headroom, valve access, openings, equipment clearances, and clearances for other work.

K. Give particular attention to piping in the vicinity of equipment.

L. Preserve the maximum access to various equipment parts for maintenance.

M. Do not cut or weaken any structural member.

N. Cut all pipes accurately to measurement determined at the site.

O. After cutting pipe, ream it to remove burrs.

P. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing.

Q. Use fittings to make all changes in direction.

R. Field bending and mitering are prohibited.

S. Make all connections to equipment using flanged joints or unions.

T. Make reducing connections with reducing fittings only.

U. Do not allow piping to pass through or over designated electrical rooms.

V. Compression fittings are not allowed.

3.2 VALVES, UNIONS, STOP COCKS, ETC.

A. Locate all valves so that their bonnets may be easily removed.

B. Move all flange valves shown in horizontal positions so that valve stem is inclined one bolt hole above the horizontal position.

C. Make-up all screwed pattern valves placed in horizontal lines so that their valve stem is inclined at an angle of 30 degrees above the horizontal position.

D. All valve stems must be true and straight at the time the system is tested for final acceptance.

E. Pack all valves and leave perfectly tight at the completion of the work.

F. Provide access doors as required for these valves.

G. Furnish locations of all access doors to the Engineer.

3.3 PIPING JOINTS

A. Screwed Pipe Joints:
   1. Provide full cut pipe threads.
   2. Assemble joints with an approved compound applied to only the male threads.
   3. Leave a maximum of three pipe threads exposed where the joint is assembled.

B. Welded Pipe Joints:
   1. Fuse weld by using a metallic arc welding process.
   2. Conform to the current recommendations of the American Welding Society for all welding operations.

C. Mechanical Coupling Joints for Copper Systems:
   1. Grooved-End-Tube Couplings: Ductile iron conforming to ASTM A-536, Grade 65-45-12, coated with copper colored alkyd enamel. Housings cast with offsetting, angle-pattern bolt pads to provide rigidity. Coupling Gaskets: Grade “P” Fluoroelastomer compound with red and blue color code designed for operating temperatures from 0 deg F to +180 deg F.
      a. Center-leg gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth.
      b. Installation Ready direct-push-installation
      c. Reference shall always be made to the latest published Victaulic Selection Guide for Gaskets for proper gasket selection for the intended service.

d. Basis of design Victaulic Style 607 or engineer approved equal

2. Fittings: Fittings shall be manufactured to copper tubing sizes, with grooves designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper, conforming to ASTM B-75 alloy C12200 or ASTM B-152 alloy C11000 and ANSI B16.22, or bronze sand-casting ANSI B16.18 and UNS-C89836. Victaulic Copper Connection Fittings.

D. Solder Joints:
1. Assemble with square cut pipe using a pipe cutter.
2. Hacksaw-cut pipe ends will not be acceptable.
3. Ream open pipe end to full size.
4. Burnish both the pipe and fitting absolutely clean.
5. Apply brazing flux to both the pipe and the fittings.
6. The use of corrosive acid flux will not be permitted.
7. Charge the pipe and fittings with nitrogen gas during the brazing.

E. Hubless Cast Iron Soil Pipe Joints:
1. Make with an approved neoprene gasket and stainless steel retaining sleeve.
2. Mark no-hub gaskets with the manufacturer's name, ASTM C 564, the word "No-Hub", nominal diameter and the CI symbol of the Cast Iron Soil Institute indicating it meets the standard.
3. Mark stainless steel couplings for no-hub "All Stainless", name of manufacturer, words "No-Hub", nominal diameter and the CI symbol indicating it conforms to CISPI Standard 310.
4. Install the hubless cast iron soil pipe systems in accordance with CISPI Pamphlet 100 - Installation Suggestions for CI No-Hub Pipe and Fittings.
5. Provide identifying markers for stainless steel couplings and neoprene gaskets to indicate compliance with CISPI-310.

F. Positive-Seal One Piece Elastomeric Compression-Type Gasket:
1. May be used for joining hub and spigot cast iron soil pipe as an alternate for lead or oakum joints or for drainage and waste system above and below ground.
2. Form the joint by inserting an approved gasket in the hub.
3. Lubricate the inside of the gasket and push the spigot end of the pipe into the gasket until seated, thus effecting a positive seal.
4. Use neoprene compression gaskets for cast iron soil pipe, marked as such, with ASTM C564 and the CI symbol of Cast Iron Soil Pipe Institute to indicate the gasket meets the standard.

G. PVC Pipe Joints:
1. May be solvent cemented using the proper cement recommended for the particular materials.
2. Cut all pipe square and clean both pipe and fittings of all soil, dirt, oil and grease.
3. Make solvent joints in accordance with the applicable ASTM Standards.
4. Allow joints to dry before testing.
5. If any leak occurs during the water test, then replace the defective joint.
6. Comply with requirements of the NSF Standard 14 for all solvent cements and primers and label to identify the laboratory certifying compliance for the particular cement and primer being used.
7. Plastic pipe and fittings for sewer and water pressure lines may also be joined by use of elastomeric (O-ring gasket) joints when the respective standards for the materials so specify. No-Hub fittings are not allowed on PVC sanitary sewer and storm drain piping under slab or underground.
8. Do not use pipes with cracked bells.
9. **PVC pipe and pipe fittings are not allowed in any return air plenum serving mechanical systems. Use cast iron piping above slab for these installations.**

3.4 SLEEVES

A. Above Grade and/or Dry Locations:
   1. Walls:
      a. Mount flush on both sides.
   2. Floors:
      a. Mount 2 inches above finished floor in pipe chases.

B. Below Grade and/or Moist Locations:
   1. Install suitable flange in the center of wall or floor to form a waterproof passage.
   2. Fill the void space around the pipe with jute twine or Oakum caulk or an asphalt based compound to insure a waterproof penetration.

C. Passing Through Fire-Rated Enclosure:
   1. Fill the void space around the pipe in accordance with NFPA requirements.
   2. Do not allow the sleeve installation to lower the fire rating of the assembly.

3.5 SECURING AND SUPPORTING OF PIPE

A. Support all pipe from the building structure by means of approved hangers and supports while maintaining required grade and pitch, preventing vibration and providing for expansion and contraction.

B. Secure all hangers to approved inserts wherever possible.

C. Set hanger inserts in place when the concrete is poured.

D. If Joists Are Used for Attachment:
   1. 2" diameter or smaller:
      a. May be attached to the bottom of joists.
   2. Greater than 2" diameter:
      a. Must be attached to the top cord of the joists.
   3. Do not support any piping and trapeze hangers from joist bridging on roof and floor deck.

E. If Structural Steel Framing Is Used for Attachment:
   1. Use approved beam clamps.
   2. Where required, install channels to span between framing members.
   3. Do not attach hangers to the roof deck or cross bracing.

F. Hanger Spacing:
   1. Schedule 40 PVC Piping:
      a. All Sizes:
         (1) 4'-0"
   2. Ferrous (Schedule 40) Piping:
      a. 1/2" diameter pipe:
         (1) 6'-0" or less
      b. 3/4" diameter pipe:
         (1) 8'-0" or less
      c. 1-1/4" diameter pipe:
         (1) 10’-0” or less
      d. Vertical:
         (1) Every Floor Level Minimum
   3. Copper (Water Tube) Piping:
      a. Smaller Than 1¼”:
         (1) 6'-0"

b. 1 ½" and Larger:
(1) 10'-0"
c. Vertical:
(1) 10'-0"

4. Cast Iron Piping:
a. All pipe sizes:
(1) One hanger per length of pipe and not exceeding 5'-0" O.C.
b. Vertical:
(1) Every Floor Level Minimum

G. Vertical Lines:
1. Adequately support at their bases, either by a suitable hanger placed in the horizontal line near the riser, or by a base fitting set on a pedestal or foundation.
2. Support from each floor slab by means of an approved clamp-type support which bears on the slab or beam.

H. Change of Direction:
1. Install supports within two feet of change of direction.
2. Brackets of approved type may be used along the walls.
3. Install hangers within 2 feet of each change in vertical or horizontal direction, pipe tees and on each side of valves, strainers, etc.
4. Multiple horizontal pipes, smaller than 12" diameter pipe, may be supported on trapeze hangers. Space trapeze hangers in accordance with the schedule for pipe spacing based upon the smallest size pipe.
5. Properly size the trapeze members for the piping load they are to support. The number of pipes on the trapeze must be approved by the Engineer to prevent overloading of the building structure.
6. Where pipes are insulated, oversize the hanger accordingly to accommodate the outside diameter of the insulation. Provide half-round 16 gauge galvanized steel shields, not less than 12" long and rolled to fit the insulation diameter, between the insulation and the hanger.
7. When pipe is guided at top and bottom, cover the entire pipe circumference with metal shields.
8. Adhere metal shield to the insulation so that the metal will not slide with respect to the insulation.
9. Wood struts shall not be used to support piping in walls.

3.6 EXCAVATION AND BACKFILLING

A. Excavation:
1. Call utility companies before digging.
2. Call Notifications Center before digging.
3. Excavate trenches for underground piping to the required depths with bell holes being provided as necessary to insure uniform bearing. Dig all bell holes after the trench has been graded.
4. Refill excavation below the required grade of piping with fine granular material to the pipe grade.
5. Where rock is encountered, excavate to a grade 3 inches below the lowermost part of the pipe and refill with fine granular materials to the pipe grade.
6. Sheath, brace, pump or bail the trenches as required to protect workmen and structures and to permit execution of the work. A trench greater than 5 feet deep will not be permitted unless the sides are cutback at 45 degrees to 5 feet or less. If this cannot be accomplished, hire a Registered Engineer to design shoring.
7. Install all underground piping below the frost line and in no case less than 18 inches below the surface.

3.7 EQUIPMENT PLUMBING CONNECTIONS

A. Make all final connections to all pieces of equipment which require natural gas, water, drain, waste or vent connections.

B. Provide all required shut-off cocks, valves, drain valves and traps.

3.8 TESTING AND INSPECTION

A. Perform all tests as specified in Division 22 or as required by the Engineer or by the Local, Federal, and State Bureaus having jurisdiction and under their supervision during the progress and upon completion of work.

B. Include costs of all required tests in your bid.

C. Provide all apparatus, temporary pipeline and all other requirements necessary for such tests.

D. Take all due precautions to prevent damage to the building or its contents incurred by such tests as the Contractor will be required to repay and make good any damage so caused at his own expense.

E. Immediately repair any leaks, defects or deficiencies discovered as a result of the tests. Repeat until test requirements are in full compliance.

3.9 IDENTIFICATION OF PIPING AND EQUIPMENT

A. Mark all piping to show the service and direction of flow.

B. Place markers at each branch of tees, at equipment connections, and change of direction and at 20 foot intervals. Minimum of one (1) marker in each room.

C. Install valve tags on all valves.

D. Frame under glass cover and hang a type written list including the valve number, type of service, and location of each valve in the boiler mechanical room.

E. Mark all valve numbers corresponding to this system of identification on the as-built drawings which will be delivered to the Owner upon completion of the work.

END OF SECTION

SECTION 22 05 54

PLUMBING IDENTIFICATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

A. Identification required for plumbing systems.

B. Code required identification not shown on plans nor specified herein shall be provided.

1.3 RELATED SECTIONS

A. Section 22 00 10 - Basic Plumbing Requirements

B. Section 22 05 30 - Pipe and Pipe Fittings - General

1.4 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 22 00 10, General Conditions, and Division 01.

B. Submit wording of nameplates with submittals.

C. Submit list of all products incorporated in this section.

1.5 REFERENCES

A. Comply with ANSI A13.1

B. USAS Code B31.8

C. NTSB-PSS-73-1

D. AGA

E. API

1.6 DESCRIPTION OF WORK

A. Provide signs for the following equipment identification:
   1. Water Heaters
   2. Piping
   3. Pumps
   4. Starters
   5. Valves

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Seton

B. Brady

C. Marking Services, Inc.

2.2 EQUIPMENT LABELS

A. Type:
   1. Engraving-Stock, melamine plastic laminate, 3 layer.
      a. Thickness:
         (1) Less than 25 square inches: 1/16 inch
         (2) 25 square inches or more: 1/8 inch

B. Color:
   1. Black

C. Conform to FS L-P-287

2.3 LETTERING

A. Style:
   1. Engraved standard print, unless otherwise indicated.

B. Size:
   1. 3/16 inch to 1/4 inch

C. Color:
   1. White letters, black background

2.4 SIGN INFORMATION

A. Plumbing Equipment:
   1. Unit mark from Drawings/Owner
   2. Voltage - Phase
   3. Manufacturer and Model Number

2.5 NAMEPLATE FASTENERS

A. Securely attach nameplates to equipment with non-corroding stainless steel screws.

B. Non-corroding pop rivets are acceptable.

C. Stick-ons or adhesives will not be allowed.

2.6 PIPING AND CONTROL DIAGRAM SIGNS

A. Material:
   1. 1/4 inch acrylic cover and backing screwed together with brass screw/bolts.
   2. Size:
      a. Minimum:
         (1) 12" x 17"
      b. Maximum:
         (1) 24" x 36"

B. Provide a diagram in each mechanical room similar to the diagrams shown on the plans, and/or as required for the area served.

C. Provide pipe markers with the following features.
   1. Letters from 1/2" to 3-1/2":
      a. Size letters to afford readability from the appropriate viewing position.
   2. Repeated and reversed words for viewing from 360º around pipe.
   3. Self-clinging, coiled markers that snap into place around pipe and do not require any other securement.
   4. Integral directional arrows.

D. Letters on Field:
   1. Identify the specific material conveyed, e.g., "Domestic Cold Water", "Domestic Hot Water", etc.

E. Model:
   1. Less than 3/4":
      a. Tags, same as Paragraph. Piping System Devices, color codes for hazard.
   2. 3/4" up to 6":
      a. Seton Setmark SNA snap-on.
   3. Over 6":
      a. Seton Setmark STR strap-on, with stainless steel spring straps.
   4. Use Seton Ultra-Mark for outdoor use.

F. Piping System Devices (Valves, Thermometers, Pressure Gages, etc., and Pipe Less Than 3/4"):
   1. Identify with the following:
      a. Tags:
         (1) Not less than 1-1/2 inch brass or aluminum tags, round, square, or octagonal.
      b. Stamp tags with minimum 1/2" high descriptive characters, 1/2" high numbers with black enamel-filled indentations.

G. Attachment:
   1. Stainless steel or solid brass jack chain; Seton JA16, or stainless steel or brass "S" hooks

H. Underground Warning Tapes:
   1. Provide materials that meet the codes or have the approvals listed below:
      a. Office of Pipeline Safety Regulation, USAS Code B31.8.
      b. GSA Public Building Service Guide Specification.
      c. National Transportation Safety Board Report NTSB-PSS-73-1.
      d. AGA Report 72-D-56.
      e. API Report API RP 1109.
   2. Material:
      a. Plastic, continuous tape, color-coded, marked for hazard.
      b. For Non-metallic Piping System:
         (1) Aluminum foil core encased in plastic.
      c. Metallic Piping:
         (1) Plastic tape.
   3. Color:
      a. Colored (not printed color) plastic, coded for material conveyed by piping.
   4. Width:
      a. As scheduled for piping system burial depth.
   5. Legend:
      a. "Caution [System Name] Line Buried Below".

6. Tape Colors:

Utility	**Color**
Natural Gas, Oil, Dangerous Materials	Hi Visibility Safety Yellow
Communications	Safety Alert Orange
Water Systems	Safety Precaution Blue
Sewer Systems	Safety Green

7. Model:
   a. Metallic Piping System: Seton Polyethylene Tape.
   b. Non-Metallic Piping System: Seton Metallic Detection Tape.

I. Underground Gas Piping:
   1. Attach No. 18 gauge copper tracer wire to the piping and terminate above grade at each end.

J. Pipeline Markers for Pipe Beneath Pavement and Slabs:
   1. Minimum 2" round, square, or octagonal, same as specified in Subparagraph: Piping System Devices.
   2. Attachment:
      a. 1-1/2" screw, bolted to tag as anchor.
      b. Anchor Setting Compound: Epoxy or epoxy grout, compatible with the pavement.

PART 3 EXECUTION

3.1 GENERAL

A. Contractor shall verify room numbers with Owner/Engineer before nameplates are fabricated.

B. The following shall be permanently and clearly identified:
   1. Each valve and pump.

3.2 INSTALLATION

A. Install signs on non-removable panels. Attach to equipment with pop rivets or stainless steel screws.

B. Mount in an easily visible location.

C. All labeling identification shall conform to final room numbers. Coordinate with General Contractor, Architect and Owner to secure construction room numbers.

D. Provide all additional signage required by local authority at no cost to the Owner.

E. Complete installation in accordance with ANSI A13.1 and manufacturer's installation instructions and with the Drawings. Fasten each unit securely in place with stainless steel screws.

F. Equipment Labeling:
   1. Install on scheduled items of equipment, including the following:
      a. Water heaters
      b. Pumps
      c. Control panels and major control components
      d. Other items of equipment
      e. Include Mark Number and descriptive name from Drawing and Specification schedules
      f. Attach with corrosion resistant, stainless steel screws or pop rivets

g. Install 1/2" diameter adhesive marker (color to be approved by Engineer), and apply to T-bar below any mechanical equipment, valves, and fire dampers above lay-in ceilings.

2. Spacing:
   a. Where pipe passes through walls, floors, and other barriers.
   b. In Tunnel Vaults and Equipment Rooms:
      (1) Maximum spacing, 10 feet; closer where piping is congested, and where piping continuity is obscured from view.
   c. Piping in Tunnels:
      (1) Maximum spacing 100 feet
   d. Other Places:
      (1) Maximum spacing 50 feet

G. Piping System Color Coding:
1. Designate for painter the following:
   a. Types of piping services
   b. Direction of flow
   c. Other information required for proper identification.

H. Surfaces to be Painted:
1. Bare piping
2. Insulation covering of insulated piping

I. Paint according to the following schedule:

System	**Pastel Color**
Exposed Domestic Cold Water	Blue
Waste and Vent	None
Exposed Gas Piping	Black

J. Piping System Devices (Valves, Thermometers, Pressure Gages, etc.):
1. Identify with the following information:
   a. System
   b. Device number
   c. Device Function
2. Device Chart:
   a. Key devices to device chart
   b. Give complete description of device function and system.

K. Key devices to drawings as follows:
1. Floor plans
2. Schematic drawings of piping systems

L. Underground Warning Tapes:
1. Tape Widths:

Piping Burial Depth	**Tape Width**
10"	2"
20"	3"
27"	6"
30"	9"
40"	12"
50" or more	18"

M. Recommended Tape Bury Depth:
  1. Minimum Depth:
    a. 6".
  2. Distance Between Pipe and Tape:
    a. Minimum 12".
  3. Maximum Depth:
    a. 12".

N. Tie tape to pipe where pipe leaves the ground.

O. Pipeline Markers for Pipe Beneath Pavement and Slabs.
  1. Location:
    a. Accuracy:
      (1) Plus or minus 6" from piping centerline.
    b. Flat Edge Pavement and Slabs:
      (1) Set within 6" of pavement or slab edge.
    c. Concrete Curbs:
      (1) Set in top of curb.
    d. Spacing:
      (1) Each change in direction, each edge of pavement or slab, maximum spacing of 100'.

P. Legend:
  1. Same as tags plus an engraved or stamped line; set marker with line parallel to buried line.

Q. Attachment:
  1. Drill hole for anchor bolt, full depth of bolt plus 1/2"; set full tag and bolt in epoxy, flush with pavement or slab.

END OF SECTION

SECTION 22 07 20

PIPING INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

A. Fiberglass insulation
   1. Applications:
      a. Above ground domestic cold water
      b. Roof drains
      c. Horizontal portions of waste lines above grade which receive condensate from air handling units
      d. Condensate drain lines
      e. Domestic hot water piping

B. Closed Cell Insulation
   1. Closed cell insulation for piping in concrete masonry unit walls only.

1.3 RELATED SECTIONS

A. Section 22 00 10 - Basic Plumbing Requirements

1.4 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 22 00 10, General Conditions, and Division 01.
   2. Submit product data indicating typical catalog of information.
   3. Submit product data sheets indicating dimensions, general assembly, and ratings.
   4. Submit manufacturer's installation instructions and method of application.

1.5 REFERENCES

A. Refer to Section 22 00 10 for complete names of references identified in this section.

ASTM E 84	Fire and Smoke Ratings
ASTM C 547	Standard Specifications for Mineral Fiber Pipe Insulation
ASTM C 585	Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)
ASTM C 795	Standard Specifications for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C 1136	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
NFPA 255	Surface Burning Characteristics of Building Materials
UL 723	Composite Surface Burning Characteristics

1.6 DEFINITIONS

A. Concealed:
1. Hidden from sight as in trenches, chases, furred spaces, walls, pipe shafts, or hung ceilings.

B. Exposed:
1. Not "concealed" as defined above. Normally open and visible to building occupants (such as gymnasiums).

1.7 QUALITY ASSURANCE

A. Fire Hazard Rating:
1. All insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E84, NFPA 255 and UL 723.
2. These ratings must be tested on the composite of insulation, jacket or facing, and adhesive.
3. Components such as adhesives, mastics and cements must meet the same individual ratings as minimum requirements.

B. Quality Controls:
1. All insulation shall be the product of reputable manufacturers.
2. All insulation shall be applied by mechanics skilled in the use of various materials, and in the employ of a concern regularly engaged in the insulating business. Submit qualifications of insulator with insulation submittals.
3. The materials shall be applied in accordance with the special materials as required by these specifications and by the manufacturer standards.
4. Poor workmanship or appearance will be cause for rejection.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Fiberglass Products:
1. Johns Manville
2. Knauf
3. Owens/Corning

B. Closed Cell Products:
1. Armacell
2. Aeroflex
3. Armstrong

2.2 GENERAL

A. Molded pipe insulation shall be manufactured to meet ASTM C 585 and ASTM C 547 for sizes required for the particular system and shall be suitable for installation on piping systems defined.

2.3 ABOVE GROUND PIPE INSULATION

A. Density - 3 pounds per cubic foot.

B. Construction:
   1. Fiberglass pipe insulation complying with ASTM C 547
   2. Vapor retarding jacket with self–sealing longitudinal closure laps and butt strips complying with ASTM C 1136.

C. Construction for Fiberglass Insulation (for all installations other than concrete masonry walls):
   1. Fiberglass with factory-applied, all service reinforced vapor barrier jacket having integral laminated aluminum vapor barrier and double adhesive self-sealing lap. Roof drain not exposed to have FRK type foil reinforced Kraft vapor barrier jacket.
   2. Thickness:
      a. Domestic Cold Water Piping:
         (1) Interior walls and above ceilings: 1/2 inch
         (2) Exterior walls: 1 inch
      b. Condensate Lines: 1/2 inch
      c. Waste Lines Which Receive Condensate: 1/2 inch
      d. Roof Drain Piping:
         (1) Exposed: 2 inch
         (2) Not exposed: 2 inch
      e. Domestic Hot Water Piping (Up to 169° F):
         (1) 2" diameter and larger:
            - Interior walls and above ceilings: 1½ inch
            - Exterior walls: 1½ inch
         (2) 1½ inch diameter and smaller: 1½ inch
      f. Outdoor:
         (1) 2 inch

D. Construction for Closed Cell Insulation (for concrete masonry wall installations only):
   1. Type: Closed-cell polyethylene pipe insulation.
   2. Performance Criteria: Resistant to ultraviolet and biological degradation.
   3. Temperature Range: -90ºF to 212ºF
   4. Water Vapor Permeability (Dry Cup): Less than 0.03 per inch when measured by ASTM C355.
   5. Thermal Conductivity: 0.265 BTU-IN/HR-F2-ºF or less at 75ºF mean temperature

2.4 FLANGE, VALVE AND FITTING INSULATION

A. Exposed Piping:
   1. Provide molded or mitered covers with full thickness matching adjacent covering.
   2. Finish with white glass, reinforced white vapor barrier coating or white .020 inch thick PVC jacketing with self-seal lap.

B. 2½ Inch Diameter and Larger Concealed Piping:
   1. Insulate fittings and valves with molded or mitered fitting covers.
   2. Finish with white vapor barrier coating reinforced with white 10" x 10" reinforced mesh.

C. 2 Inch Diameter and Smaller Concealed Piping:
   1. Insulate fittings and valves with mineral wool and insulating cement to a thickness equal to or greater than adjoining straight pipe.
   2. Molded or mitered fittings finished with white vapor barrier coating reinforced with reinforced mesh may be provided.

D. Underground Piping (hot water only):
   1. Provide mitered covers with full thickness matching adjacent covering.
   2. Field fabricated miter joints are not acceptable.
   3. No insulation is required on underground domestic cold water piping.

E. Outdoor Piping:
   1. Metal jacketing shall be 0.016" minimum aluminum or stainless steel with moisture barrier, secured in accordance with jacket manufacturer's recommendations.
   2. Use preformed fitting covers matching jacket used on straight pipe, with all joints sealed with metal jacketing sealant.

2.5 SEALANT, ADHESIVE, AND FINISH

A. Sealant:
   1. Manufacturers:
      a. Foster 95-44
      b. Childers CP-76
   2. Usage:
      a. Valve Covers
      b. Anchors
      c. Hangers
      d. Metal Jacketing
      e. Flashing Penetrations

B. Adhesive:
   1. Manufacturers:
      a. Foster 85-20/85-60 and Childers CP-127
   2. Usage:
      a. Longitudinal laps of the vapor barrier jacket
      b. Butt joint covers.

C. Weather Barrier Mastic
   1. Manufacturers:
      a. Foster 46-50
      b. Childers CP-10
   2. Usage:
      a. Used on above ambient piping/duct to protect insulation from weather.
      b. Use in conjunction with reinforcing mesh.

D. Vapor Barrier Coating:
   1. Manufacturers:
      a. Foster 30-33 Vapor Out
      b. Childers CP-33 Chil Out
   2. Usage:
      a. Glass fabric reinforcement.

E. Reinforcing Mesh
   1. Manufacturers:
      a. Foster Mast Afab
      b. Childers Chil-glass #10

2.6 INSULATION SHIELD

A. Field-fabricated:
   1. Material:
      a. High-density fiberglass insulation
   2. Construction:
      a. Insulation to support the bearing area at hangers and supports with a shield of galvanized metal extending not less than 4 inches on either side of the support bearing area, covering at least half of the pipe circumference. When pipe is guided at top and bottom, metal shields should cover the whole pipe circumference. Adhere

metal shield to insulation so that metal will not slide with respect to insulation.

3. Schedule:
   a. 3" and smaller pipe diameter:
      (1) 12 inch insulated section, 18 gauge metal shield
   b. Greater than 3" pipe diameter:
      (1) 12 inch insulated section, 16 gauge metal shield

B. Factory-made:
1. Manufacturer:
   a. Pipe Shields, Inc. or equal.
2. Type:
   a. Proper shield for service and pipe span.
3. Construction:
   a. Extend insulation at least 1 inch beyond metal.

C. Insulation shall not compress at hanger.

PART 3 EXECUTION

3.1 SITE INSPECTION

A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.

B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 PROPERTIES

A. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.3 INSTALLATION

A. General:
1. Install all insulation materials and accessories in accordance with manufacturer's published instruction and recognized industry practices to ensure that it will serve its intended purpose.
2. Install insulation on piping subsequent to installation of heat tracing, painting, and acceptance tests.

3. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.
4. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with suitable vapor barrier coating to maintain vapor barrier integrity.
5. All cold water, hot water and condensate drains routed in concrete masonry units shall be insulated using closed cell insulation as noted in this specification.

3.4 PIPE

A. Insulation size shall match pipe size.

B. Insulation to be continuous through wall and ceiling penetrations.

C. Apply insulation to clean, dry pipes.

D. Butt insulation joints firmly together and apply butt strip. All pipe insulation ends shall be tapered and sealed.

E. Butt pipe insulation against hanger inserts. Seal jacketing according to type used.

F. Seal longitudinal laps and butt strips with sealant in addition to the self-sealing laps.

G. Seal joints with adhesive and staple at 2" O.C. with outwardly clenching staples.

H. Seal all joints with vapor barrier coating.

3.5 VALVES, FLANGES, AND FITTINGS

A. Insulate all valves, flanges, and fittings with covers secured with Velcro with equivalent thickness and composition installation on straight pipes.

B. Finish with 1/4 inch layer of Foster 30-33 or Childers CP-33 reinforced with reinforcing mesh.

C. Factory made covers equal to Schuller Zeston are acceptable.

3.6 CONTROL VALVE COVERS

A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.

B. Seal covers to valve insulation properly with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve.

C. Finish valve cover with glass cloth and two coats of vapor barrier coating.

D. Factory made covers are acceptable. Provide submittal.

3.7 ROOF DRAIN PIPING

A. Wrap insulation tightly on the pipe with all circumferential joints butted and longitudinal joints overlapped a minimum of 2 inches.

B. Adhere insulation to metal with 4 inch strips of insulation bonding adhesive at 8 inch on centers. On circumferential joints, the 2 inch flange of the facing shall be secured and taped with a minimum of 3 inch wide foil reinforced Kraft tape. On longitudinal joints, the overlap shall be secured using 9/16" flared door staples applied 6" on centers and taped with minimum 3" wide foil reinforced Kraft tape.

C. Seal vapor tight to prevent any moisture from leaking out from under the insulation.

D. Roof drains for canopies do not require insulation.

E. Roof drains that are exposed shall be insulated as described in the paragraph on exposed piping.

F. Roof drain laterals which serve primary roof drains shall be insulated.

G. No insulation is required on concealed secondary roof drain piping.

H. Insulate all roof drain bodies (primary and secondary), first 3-feet of vertical pipe on secondary laterals, and primary roof drain piping to a point seven feet downstream of the first elbow.

3.8 WASTE LINES WHICH RECEIVE CONDENSATE

A. Insulate from the drain receptor (i.e. floor sink, hub drain) all the way to where the drain line changes to a vertical stack.

3.9 REPAIRS AND REPLACEMENT

A. Replace any insulation that gets wet, whether now dry or not.

B. Repair any damage caused by condensation due to improper insulating.

3.10 ALL EXPOSED PIPING

A. All exposed piping insulation to be pre-formed pipe insulation with white PVC jacket and white PVC fittings (no exceptions). All exposed roof drain primary and secondary downspouts, water piping, condensate piping, and any other piping that requires insulation shall be insulated down to the floor level using the pre-formed pipe insulation and PVC jackets and fittings.

3.11 OUTDOOR PIPING

A. Metal jacket shall be applied per manufacturer's recommendations. Longitudinal joints shall be applied so they will shed water completely and be sealed completely with 1/8” bead of metal jacketing sealant under each lap. Circumferential joints shall be closed using preformed butt strips in accordance with manufacturer's recommendations.

3.12 SHIELDS

A. Metal jacketing shall be 0.016-inch minimum aluminum or stainless steel with moisture barrier, secured in accordance with jacket manufacturer's recommendations. Use bands and seals of the same material. Use preformed fitting covers matching jacket used on straight pipe, with all joints weather sealed with 1/8” bead of metal jacketing sealant under each lap.

3.13 SHIELDS AND HANGERS

A. Piping hangers or anchors are not to be in direct contact with pipe. Hangers are to on the outside of the insulation with pipe shields at each hanger.

B. At the location of hangers or supports for pipes run above ground and finished with a vapor seal insulation, provide rigid sections of cork, high density fiberglass, Foamglas, calcium silicate or high density polyurethane, the same thickness as adjacent insulating material to adequately support the pipe without compression of the insulating material and cover with a vapor seal that is bonded to the adjacent insulation as described for fittings in the lines. Wood inserts shall not be allowed. Hangers and supports for piping insulation to receive a vapor barrier shall be installed exterior to the insulation.

C. Material Changes:
   1. Wherever there is a change in materials on lines that are vapor sealed, apply a suitable adhesive that is compatible with both materials, tapes, etc., as required to maintain the vapor barrier.

D. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe.

E. Take care to avoid puncturing the vapor seal.

F. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.14 FIELD QUALITY ASSURANCE

A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.15 PROTECTION

A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation contractor shall advise the general and/or the mechanical/plumbing contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

END OF SECTION

SECTION 22 13 18

CONDENSATE PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

A. Condensate piping for cooling units.

1.3 RELATED SECTIONS

A. Section 22 00 10 - Basic Plumbing Requirements

B. Section 22 05 30 - Pipe and Pipe Fittings - General

C. Section 22 07 20 - Piping Insulation

1.4 REFERENCES

A. ASTM B88 - Seamless Copper Tube for Water, Gas & Sanitation

B. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV)

1.5 DEFINITIONS

A. Draw-through Unit:
   1. A unit in which the cooling coil operates under a negative static pressure.

B. Blow-through Unit:
   1. A unit in which the cooling coil operates under a positive static pressure.

1.6 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 22 00 10, General Conditions, and Division 01.
   2. Submit product data indicating typical catalog of information.
   3. Submit product data sheets indicating dimensions, general assembly, and ratings.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide condensate lines for all cooling units even if not shown on the plans.

B. Provide a secondary condensate drain pan and secondary condensate piping for all horizontal air handlers above ceiling, even if not shown on plans.

C. Minimum size:
   1. 1", but no smaller than the coil nipple.

2.2 PIPING

A. Type:
   1. Hard drawn type DWV or type M copper
   2. Other type as noted on plans
   3. Conform to ASTM B306 or ASTM B88.

2.3 FITTINGS

A. Type: Cast Copper Alloy Solder Joint Drainage Fitting-DWV
   1. Conform tot ASME B16.23
   2. Provide dielectric insulating couplings between ferrous and copper piping systems.

2.4 INSULATION

A. All condensate lines shall be insulated per Section 22 07 20.

2.5 CONNECTIONS

A. Type:
   1. Solid string hard solder
   2. Wire hard solder
   3. Cored solder will not be allowed.

B. Material:
   1. Solder:
      a. 95% tin and 5% antimony
   2. Flux:
      a. Non-corrosive paste type

C. Use a cast adapter when connecting soldered copper piping to screwed brass pipe.

2.6 ROOF PIPE SUPPORTS

A. Manufacturers:
   1. MAPA MS-5
   2. Miro Industries Model 3 RAH (3-inch or less)
   3. Pipe Hangers and Devices (PHP) Model PP10
   4. Portable Pipe Hangers (PHP) Model PP10
   5. ERICO RPS 360407

B. All roof supports to be equal to MAPA Products Model MS-5, adjustable height, select size designed for size of pipe supported. MS-5 for 4” and smaller.
   1. Install ½” rubber walk pad under each pipe support.

C. MAPA MWP ½” thick rubber walk pad.
   1. Coordinate exact locations of supports with roofing contractor.

D. Roof supports to support all gas piping a minimum of 6" above roof.
   1. Coordinate exact locations of supports with roofing contractor.
   2. Install ½” rubber walk pad under each pipe support.

E. Spacing of Supports (Horizontal):
½" 6 feet or less
¾" or 1" 8 feet or less
1¼" or larger 10 feet or less
Install supports within 2 feet of every change of direction.

2.7 ACCESSORIES

A. Traps:
1. Draw-through units:
a. Required on all units, unless noted otherwise on plans.
2. Blow-through units:
a. As recommended by the unit manufacturer or as shown on the plans.

B. Clean-outs

C. Unions

D. Neutralization kits for all condensing furnaces and condensing water heaters.
Equal to JJM Boiler Works, Inc.

PART 3 EXECUTION

3.1 INSTALLATION

A. Traps:
1. Install in each line serving a draw-through unit. Coordinate size and configuration with air conditioning unit manufacturer.

B. Cleanouts:
1. Install cleanouts as shown on plans.
2. Install cleanouts at changes in direction (greater than 45º).
3. Provide insulation caps on cleanouts for easy removal and reinstall.

C. Unions:
1. Install unions on both sides of the trap.

D. Minimum Drain Line Slope:
1. 1/8 inch per foot
2. Insulate all condensate lines inside buildings.

E. At all rooftop units on the roof, contractor to connect to the side outlet on the rooftop unit condensate drain pan and then route condensate drain down through roof in roof penetration per the roofing consultant's roof penetration detail. The bottom outlet on the rooftop unit condensate drain pan is unacceptable. The P-trap must be accessible on the roof.

F. TESTING:
1. Pressure test all sections of the condensate drainage system at a 10 foot head pressure for a 24 hour period. Repeat test until no leaks exist.

END OF SECTION

SECTION 22 16 01

NATURAL GAS PIPING AND APPURTENANCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 22 00 10, apply to this Section.

1.2 SECTION INCLUDES

A. Natural gas piping

1.3 RELATED SECTIONS

A. Section 22 00 10 - Basic Plumbing Requirements

B. Section 22 05 24 - Valves - General

C. Section 22 05 30 - Pipe and Pipe Fittings - General

1.4 REFERENCES

ASTM A-53	Pipe, steel, black and hot-dipped, zinc coated, welded and seamless
ASTM A-240/A240M-09b	Standard specification for chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels and for general applications
ASTM D-2774	Underground installation of thermoplastic pressure piping
ASTM E84-09c	Standard test method for surface burning characteristics of building materials
ASTM F-1668	Construction procedures for buried plastic pipe
UL 181BM	Procedures for HVAC system design and installation
NFPA - 54	National Fuel Gas Code
AWS	American Welding Society
ASTM D2513	Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
ASME B16.44	Manually operated metallic gas valves for use in gas piping systems up to 5 psi.
ANSI Z21.15	Manually operated gas valves for appliances, appliance connector valves, and hose end valves.

1.5 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 22 00 10, General Conditions, and Division 01.

B. Submittals shall include:
   1. Pipe
   2. Pipe Supports
   3. Fittings
   4. Regulators

5. Sleeving Materials
6. All accessories

C. Submit product data indicating typical catalog of information including arrangements.

D. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication.

1.6 COORDINATION

A. Coordinate installation of the gas piping with the City.

B. Obtain approval from the City of all pipe sizes before installing any piping.

C. Call gas company and Notification Center before digging.

1.7 QUALITY ASSURANCE

A. All welders shall be certified by AWS or other accredited program.

PART 2 PRODUCTS

2.1 PIPING AND FITTINGS

A. Press type fittings (equal to Megapress and Powerpress) <u>will not</u> be accepted as an equal to welded and threaded fittings.

B. Above the slab and within the interior of the building:
1. Standard weight, Schedule 40 black steel pipe with malleable iron fittings. Conform to ASTM A-53. Threaded on all gas piping on roof 2 inches in diameter and smaller, butt joint welded on roof on all 2-1/2" diameter and larger, and socket welded fittings on ALL fittings and joints inside the building.

C. Outside of the building and below grade:
1. Polyethylene gas pressure pipe and fittings with fused joints.

D. Transition Service Riser:
1. Manufacturer/Model:
   a. Central Plastics Co. (Shawnee, OK) 610-0111
2. Use for the underground riser leading into the building.

2.2 GAS COCKS

A. Type:
1. Brass with tee or square head for wrench operation.

2.3 UNIONS

A. Type:
1. Malleable iron, insulating type.

2.4 VALVES

A. Provide an approved design which does not allow locking in the open position.

B. Larger than 2 inches:
   1. Provide with a lubricated stop.

2.5 GAS PIPE SLEEVING

A. Pipe:
   1. 10 gauge steel pipe, welded or PVDF for mechanical plenum returns.
   2. Sleeving material in accordance with Local Authority having jurisdiction and per mechanical system type

B. Prior to installation verify with City all approved methods of gas pipe sleeving.

2.6 SOCKET WELD FITTINGS

A. Manufacturer:
   1. Anvil

2.7 ROOF PIPE SUPPORTS

A. Manufacturers:
   1. MAPA MS-5
   2. Miro Industries Model 3 RAH (3-inch or less)
   3. Pipe Hangers and Devices (PHP) Model PP10
   4. Portable Pipe Hangers (PHP) Model PP10
   5. ERICO RPS 360407

B. Manufacturer to select correct size for size and weight of pipes.

C. Pipe models listed above are for 3-inch or smaller gas pipe.

D. All roof supports to be equal to MAPA Products Model MS-5, adjustable height, select size designed for size of pipe supported. MS-5 for 4” and smaller.
   1. Install ½” rubber walk pad under each pipe support.

E. MAPA MWP ½” thick rubber walk pad.
   1. Coordinate exact locations of supports with roofing contractor.

F. Roof supports to support all gas piping a minimum of 6" above roof.
   1. Coordinate exact locations of supports with roofing contractor.
   2. Install ½” rubber walk pad under each pipe support.
   3. Spacing of Supports (Horizontal):
      ½” 6 feet or less
      ¾” or 1” 8 feet or less
      1¼” or larger 10 feet or less
      Install supports within 2 feet of every change of direction.
   4. Spacing of Supports (Vertical):
      ½” 6 feet or less
      ¾” or 1” 8 feet or less
      1¼” or larger 10 feet or less
      Install supports within 2 feet of every change of direction.
      At least every floor level install supports within 2-feet of every direction.

2.8 MEDIUM PRESSURE REGULATORS

A. Manufacturers:
   1. Itron B34 Series or as shown on drawings.
   2. Fisher or equivalent

2.9 GAS METERS

A. Make all arrangements with local gas utility company to obtain gas service. Coordinate exact location of meter, correct size, and pressure with gas utility company as indicated on plans.

PART 3 EXECUTION

3.1 POLYETHYLENE PIPING

A. Install a minimum of 18 inches deep.

B. Attach a number 18 copper tracer wire to the piping and terminate above grade at both ends.

C. Do not bend the piping to a radius of less than 20 times the nominal diameter of the pipe.

D. Installed piping with enough slack to ensure that it will not be subjected to thermally induced strain which could damage the piping system.

E. Fusion joints according to manufacturer’s instruction.

3.2 BLACK STEEL PIPING

A. Make all joints above grade and on roof gas piping 2-1/2" and larger by welding.

B. Do not install steel piping underground, except at risers.

C. Protect all underground black steel piping, (including underground riser to a point at least 6 inches above grade) where exposed on the exterior against corrosion by means of yellow "polyken" wrapping, 3M #51 "Scotchwrap", or Republic Steel's "X-Tru-Coat". Gas pipe protective coatings shall be approved types, machine applied conforming to recognized standards.

D. Field wrapping shall provide equivalent protection and is restricted to those short sections and fittings necessarily stripped for threading or welding.

E. Provide a #17 anode, insulating fittings, etc., for cathodic protection at the meter and each entry underground.

3.3 GAS COCKS

A. Provide all final connections with gas cocks.

B. Mount gas cocks in vertical pipes only on all rooftop gas-fired equipment.

3.4 GAS TURRETS IN SCIENCE/BIOLOGY/CHEMISTRY LABS

A. Plumbing contractor to provide low pressure gas piping, routed behind casework or in wall to each and every gas turret on laboratory casework. Coordinate all turret locations with the architect’s laboratory casework plan.

3.5 VALVES

A. Provide all outlets at individual sites and any building supplied by the system with a readily accessible approved valve.

B. Install valves in the gas piping within 3 feet of each appliance and ahead of the union connection.

3.6 MEDIUM PRESSURE REGULATORS

A. All regulators shall be located in mechanical rooms, or on roofs as shown on plans.

B. Each regulator shall have a separate vent to the outside.

C. Each regulator shall be installed with an approved gas valve upstream of each regulator.

D. Gas regulators to be installed no closer than 10’-0” to any outside air intake.

3.7 GAS PIPE SLEEVING LOCATIONS

A. Sleeve all gas piping routed in concrete masonry walls and extend vent up through gooseneck roof termination. Gas piping routed down ICF or tilt wall panels shall not be routed in these walls. Route down along these wall types in chase wall.

B. Vent all science/biology/chemistry valve enclosures up thru roof and terminate on roof with a gooseneck. Coordinate all valve enclosures with electrical contractor. Furnished by the electrical contractor and installed by the plumbing contractor.

C. Sleeve all gas pipe roof penetrations from the hooded roof penetration thru the roof decking. Penetration at decking to be cut neatly and shall match the perimeter of pipe to allow fire putty application.

D. At the main gas line building entry up to roof, sleeve gas piping from the point of entry up to the hooded roof penetration.

E. All gas lines serving science/biology/chemistry demonstration desk will be sleeved in Pipe and fittings to be glued and tested for leaks before backfilling. Sleeve ends to extend no less than 6” above slab.

F. Sleeve all gas piping routed down in walls that are fire rated or are sound walls that have sheetrock extending up to the bottom side of the roof decking. Sleeve to terminate on room side of entry point and exit point of gas piping.

3.8 SOCKET WELD FITTING LOCATIONS

A. All interior gas piping in all locations (other than those locations in section 3.7 of this specification) to be installed using socket weld fittings. Install per manufacturers recommendations.

3.9 UNIONS

A. Install a union at every fifty feet of roof piping, every change in direction, and at each gas regulator assembly, as noted on gas regulator detail.

3.10 CONNECTIONS TO EQUIPMENT

A. Connect the gas piping with pipe fittings.

B. Provide for thermal expansion for straight runs of pipe over 100 feet.

C. Flexible connectors will not be allowed to any equipment. Connect with black steel pipe and unions.

3.11 GAS METER

A. Coordinate with gas utility.

3.12 SLOPE

A. Slope all pipe a minimum of 1/4 inch per 15 feet to prevent traps. All horizontal lines shall slope to the risers and slope from the risers to the meter or to a service regulator when a meter is not provided.

B. If a trap is unavoidable, a drip leg shall be installed. Drip legs shall be installed at the meter and at all appliances. Drip leg to be a minimum of 4” from tee turn down to cap.

3.13 PAINTING

A. Paint in accordance with architectural specifications and color selected by Architect. Color to be flat black on roof and to match wall color on vertical riser to roof if color not otherwise instructed.

3.14 INSPECTION

A. Do not enclose or cover any work until it has been inspected, tested and accepted by local authority having jurisdiction.

3.15 TESTING

A. Procedure:
   1. Subject gas piping systems to a pneumatic pressure test of 60 pounds per square inch for 30 minutes.
   2. While the systems are subject to this air pressure, apply a soapy water solution to all welded joints for the purpose of detecting minute, as well as larger leaks.
   3. If leaks are found in welded lines, repair by chipping and rewelding operations.
   4. Repeat alternate testing and rewelding operations until the gas piping systems are absolutely tight.
   5. If leaks occur at threaded joints, eliminate such leaks by replacing the fittings or properly tightening them.
   6. Finally, subject the entire gas piping system to a pneumatic pressure test of 50 psi for a period of 24 hours and demonstrate that the piping system is absolutely tight.

B. Perform any other tests as required by the City or other governing bodies.

END OF SECTION

2022 ESSER HVAC RENOVATIONS TO MULTIPLE CAMPUSES
MOUNT PLEASANT INDEPENDENT SCHOOL DISTRICT

HEATING, VENTILATING AND AIR-CONDITIONING (HVAC)

DIVISION 23

23 00 00	Basic Mechanical Requirements
23 00 90	HVAC Submittal Procedures
23 05 19	Meters and Gauges for HVAC Piping
23 05 29	Hangers and Supports for HVAC Piping and Equipment
23 05 32	Roof Curbs
23 05 33	Roof Curb Adapters
23 05 53	Identification for HVAC Piping and Equipment
23 05 93	Testing, Adjusting, and Balancing for HVAC
23 07 13	Duct and Grille Insulation
23 07 19	Hydronic Piping Insulation
23 07 21	Refrigerant Piping Insulation
23 09 23	Energy Management Control System (EMCS) BACnet/Tridium
23 09 25	Variable Frequency Drives
23 21 13	Hydronic Piping, Valves and Appurtenances
23 21 23	Hydronic Pumps
23 23 00	Refrigerant Piping
23 25 00	HVAC Water Treatment
23 31 13	Metal Ductwork
23 33 33	Access Doors
23 34 16	HVAC Fans
23 37 13	Diffusers, Registers, and Grilles
23 43 23	Bipolar Ionization Air Purification System
23 52 33	Water Tube Boilers
23 64 23	Air Cooled Scroll Compressor Chillers
23 73 13	Modular Indoor Central Station Air Handling Units
23 73 26	Dedicated Outdoor Air, Air Handling Units
23 74 13	Rooftop Central Station Air Handling Units
23 74 33	Packaged Dedicated Outdoor Air Handling Units
23 81 19	Packaged HVAC Units
23 81 26	Split System HVAC Units
23 81 27	Small Capacity Split System Units
23 81 46	Water Source Heat Pump Units
23 82 19	Fan Coil Units
23 82 39	Electric Unit Heaters

SECTION 23 00 00

BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Basic mechanical requirements necessary to provide complete installation of all Division 23 work.

1.3 WORK INCLUDED

A. This section of work comprises furnishing of all materials, equipment, tools, scaffolding, rigging, hoisting, labor and transportation necessary for the complete installation of the mechanical systems as shown on the plans and as specified herein.

B. Bidders shall determine the contents of a complete set of drawings and specifications and be aware that they may be bidding from a partial set of drawings, applicable only to the various separate contracts, subcontracts, or trades as may be issued for bidding purposes only. The contract documents and the complete scope of work for the project are illustrated on the combined Plumbing, Heating, Ventilating, Air Conditioning and Electrical, and each Bidder shall thoroughly acquaint himself with all the details of the complete set of drawings and specifications before submitting his bid. All drawings and specifications form a part of the contract documents for each separate contract and shall be considered as bound therewith in the event partial sets of plans and specifications are issued for bidding only. The submission of bids shall be deemed evidence of the review and examination of all drawings, specifications, and addenda issued for this project as no allowances will be made because of unfamiliarity with any portion of the complete set of documents.

1.4 CODES & REFERENCE STANDARDS

A. General:
   1. Perform all Division 23 work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are modified by the contract documents.
   2. Nothing in the Contract Documents shall be construed to permit work not conforming to these codes.
   3. When two or more codes or standards are applicable to the same work, then the stricter code or standard shall govern.
   4. The date of the code or standard that is in effect on the date of issue of the contract documents except when a particular publication date is specified.
   5. The Contractor shall be held responsible for verifying all local codes and ordinances that may alter any part of the plans or specifications. The Contractor shall bear all costs for correcting the deficiencies.
   6. Where local codes and ordinances are not in writing or on record, but a local precedence has been set, the Owner shall pay for any additional cost incurred.

B. Applicable Codes and Standards for All Division 23 Work:
   1. International Building Code
   2. International Gas Code

3. International Plumbing Code
4. International Mechanical Code
5. International Energy Conservation Code
6. National Electrical Code
7. American Society of Heating, Refrigerating and Air Conditioning Engineers Standards.
8. Occupational Safety and Health Administration Standards:
    a. OSHA Standard 2207 - Construction Industry Standards
    b. OSHA 29 CFR Part 1926 - Regulation of Excavation
    c. Texas Underground Facility Damage Prevention Act (H.B. 2295)
    d. All other applicable standards
9. National Fire Protection Association:
    a. NFPA No. 90A Installation of Air Conditioning and Ventilating Systems
10. Texas State Board of Insurance Standards
11. Clean Air Act and Clean Air Act Amendments
12. State Codes:
    a. Texas Department of Labor Boiler Rules and Regulations
    b. All other applicable codes
13. Local Municipal Codes and Ordinances

1.5 SCHEDULE OF ABBREVIATIONS

A. Reference Standards are listed in Section 23 using abbreviations listed below:

AABC	Associated Air Balance Council
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADC	Air Diffusion Council
A/E	Architect/ Engineer
AGA	American Gas Association
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
AHRI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
AWE	American Welding Society
AWWA	American Water Works Association
CGA	Compressed Gas Association
CISPI	Cast Iron Soil Pipe Institute
CS	Commercial Standard
CSA	Canadian Standards Association
DIPRA	Ductile Iron Pipe Research Association
DOT	Department of Transportation
DOC	Department of Commerce
FCC	Federal Communications Commission
FM	Factory Mutual
FS	Federal Specification
GSHPA	Ground Source Heat Pump Association
IBC	International Building Code
ITL	Independent Testing Laboratories
NEC	National Electric Code
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute

SMACNA	Sheet Metal and Air Conditioning National Association
TCEQ	Texas Commission on Environmental Quality
TDH	Texas Department of Health
TWC	Texas Water Commission
UBC	Uniform Building Code
UL	Underwriters Laboratories

1.6 QUALITY ASSURANCE

A. Provide complete installations of all systems.

B. Furnish all items of equipment, material, and labor to complete the Contract even though each and every item necessary is not specifically mentioned or shown.

C. In case of any conflict between the specifications, plans and ordinances, the ordinances shall govern.

D. All materials furnished under this Contract shall be new, free from defects of any kind, of the quality and design hereinafter specified, and shall conform to the standards of Underwriter's Laboratories Inc., except for equipment which U.L. does not list or provide label service.

E. All mechanical equipment and fixtures shall be the same brand unless scheduled differently on plans.

F. Contractor's Responsibility:
1. Erect barricades, protective fencing, and signs to prevent injury to personnel on site.
2. Make permanent connection to utilities or existing lines. Determine depth and location, and bid accordingly.
3. Relocate and repair any existing lines cut by general construction work.
4. Pay all costs in connection with metering devices.
5. Plans do not show exact location and elevations of lines, nor do they show all offsets required.
6. Deviate from plans as required to conform to the general construction and provide proper grading.
7. Maintain all utility services during construction to existing portions of job that remain.
8. Procure and pay for all necessary permits or licenses to carry out the work.
9. Obtain and pay for all the necessary certificates of approval which must be delivered to the A/E before final acceptance of the work.
10. Periodically remove rubbish, clean or repair all surfaces marred by the work required under this contract.
11. Protect work from damage by other trades.
12. Make all tests required by law; pay all costs in connection with the testing.
13. Where job conditions require changes in indicated locations and arrangement, make such changes without extra cost to Owner.
14. Provide motor starters, controls, relays, all low-voltage wiring, conduit and wiring related to HVAC and other equipment and devices to form a complete working system. See Section 26 00 00.

1.7 DEFINITIONS

A. Approval:
1. It is understood that approval must be obtained from the A/E in writing before proceeding with the proposed work.
2. Approval by the A/E of any changes, submitted by the Contractor will be considered as general only to aid the Contractor in expediting his work.

B. Contractor:
   1. The Contractor engaged to execute the work included in a particular section only, even though he may be technically described as a Subcontractor to the General Contractor.
   2. If the Contractor engaged to execute said work employs Sub-Contractors to perform various portions of the work included under this Section, he shall be held responsible for the execution of same, in full conformity with Contract Document requirements.
   3. The Contractor shall cooperate at all times and shall be responsible for the satisfactory cooperation of his Subcontractors with the other Contractors on the job so that all of the various phases of the work may be properly coordinated without unnecessary delays or damage to any parts of the work of any Contractor.

C. Provide:
   1. Defined as requiring the furnishing and installing of the item or facility indicated, complete in all respects and ready for operation unless otherwise specifically noted.

1.8 WARRANTY

A. The Contractor shall warranty his work against defective materials and workmanship for a period of one year from date of acceptance of the job.

B. Neither the final payment nor any provisions in Contract Documents shall relieve the Contractor of the responsibility for faulty materials or workmanship.

C. He shall remedy any defects due thereto, and pay for any damage to other work resulting therefrom, which shall appear within a period of one year from date of substantial completion.

D. The Owner shall give notice of observed defects with reasonable promptness.

E. This Guarantee shall not be construed to include the normal maintenance of the various components of the system covered by these specifications.

1.9 SITE VISIT

A. Before submitting his proposal, each bidder shall examine all plans and specifications relating to the work, shall visit the site of the project and become fully informed of the extent and character of the work required.

B. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or the amount of work to be done, it being fully understood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein, or indicated on the accompanying plans or required by nature of the site of which may be fairly implied as essential to the execution and completion of any and all parts of the work.

1.10 SUBMITTALS

A. Refer to Section 23 00 90 for submittal procedures.

1.11 PROJECT RECORD DOCUMENTS

A. The Contractor shall keep a set of plans on the job, noting daily all changes made in connection with the final installation including exact dimensioned locations of all new and uncovered existing utility piping outside the building.

B. Upon submitting his request for final payment, he shall turn over to the A/E, for subsequent transmittal to the Owner, a clean, neatly marked set of reproducible plans showing "as installed" work and an electronic file with changes of materials.

C. In addition to the above, the Contractor shall accumulate during the job's progress the following data, in duplication (2 each), prepared in 3 ring binders of sufficient size, black in color, neat in appearance, and turned over to the A/E for checking and subsequent delivery to the Owner. Electronic copies of the following are also acceptable, but they must be saved to a single flash drive or external hard drive:
   1. All warranties, guarantees and manufacturer's directions on equipment and material covered by the Contract.
   2. Approved fixture brochures.
   3. Copies of approved shop drawings.
   4. Set of operating instructions. Operating instructions shall also include recommended maintenance and seasonal changeover procedures.
   5. Any and all other data and/or plans required during construction.
   6. Repair parts lists of all major items and equipment including name, address and telephone number of local supplier or agent.

D. The first page, or pages, shall have the names, addresses, and telephone numbers of the following:
   1. General Contractor and all sub-contractors.
   2. Major Equipment Suppliers.

1.12 TRAINING

A. Upon completion of the work and at a time designated by the Owner's representative, provide a formal training session for the Owner's operating personnel to include location, operation, and maintenance of all mechanical equipment and systems, some sections have further instructions.

B. Before proceeding with instruction, prepare a typed outline in triplicate listing the subjects that will be covered. Submit the outline for review by the Owner's representative.

C. At the conclusion of the instruction, obtain the signatures of the attendees on each copy of the outline to signify that they have a proper understanding of the operation and maintenance of the system. Submit the signed outlines to the Owner's representative and Engineer as a condition of final acceptance.

1.13 PLANS AND SPECIFICATIONS

A. The plans show diagrammatically the locations of the various lines, ducts, conduits, fixtures, and equipment and the method of connecting and controlling them.

B. It is not intended to show every connection in detail and all fittings required for a complete system.

C. The systems shall include but are not limited to the items shown on the plans.

D. Exact locations of these items shall be determined by reference to the general plans and measurements of the building and in cooperation with other contractors, and in all cases, shall be subject to the approval of the A/E.

E. The A/E reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.

F. Contractor, subcontractor, vendors and suppliers are required to waive subrogation against Owner and Engineer.

1.14 UTILITIES, LOCATIONS, AND ELEVATIONS

A. Locations and elevations of the various utilities within the scope of this work have been obtained from the City and/or other substantially reliable sources and are offered separately from the Contract documents, as a general guide only, without guarantees as to accuracy.

B. The Contractor shall examine the site, shall verify to his own satisfaction the locations, elevations and availability of all utilities and services required, and shall adequately inform himself as to their relation to the work; the submission of bids shall be deemed evidence thereof.

C. The Contractor shall coordinate all services with the Utility Companies during construction, coordinate changes made by Utility Companies to the design of project, and coordinate with the Owner, A/E, and Utility the scheduling of any shutdowns or delays that may occur in providing service.

D. The Contractor shall verify location, conduct all necessary tests, inspections, coordinate with Owner's representatives and utilities, and check for existing underground utilities and lines before ditching.

E. The Contractor shall be responsible for repair of any cut or damaged lines or utilities he uncovers. There are lines and utilities not shown on any plans.

1.15 SUBSTITUTION OF PRODUCTS

A. Substitution of products specified herein will be considered only when a complete list of proposed alternative equipment is submitted to the Engineer in writing, supported by adequate technical and cost data. This includes a complete description of the proposed substitution, drawings, catalog cuts, performance data, test data, or any other data or information necessary for evaluation.

B. All proposed substitutions and data must be received by the Engineer no less than ten working days prior to the schedule date for opening of bids.

C. The Engineer will consider all such submittals and the A/E will issue an addendum listing items which the Engineer considers acceptable. Only such items as specified or approved as acceptable will be installed on this project.

D. Manufacturers' names are listed herein and on the plans to establish a standard of quality and design. Where a manufacturer's name is mentioned, products of other manufacturers will be acceptable, if in the opinion of the Engineer, the substitute material is of equivalent quality or better than that of the material specified.

E. The Contractor's Bid represents that the bid price is based solely upon the materials and equipment described in the Bid Documents (including addenda, if any) and that he contemplates no substitutions or extras.

F. Requests for substitution are understood to mean that the Contractor:
   1. Has personally investigated the proposed substitution and determined that it is equal or superior in all respects to that specified.
   2. Will provide the same guarantee for the substitution that he would for that specified.
   3. Will, at no cost to the Owner, replace the substitute item with the specified product if the substitute item fails to perform satisfactorily.

4. After Award of the Contract, substitutions will be considered only under one or more of the following circumstances:
   a. The substitution is required for compliance with subsequent interpretations of code or insurance requirements.
   b. The specified product is unavailable through no fault of the Contractor.
   c. The manufacturer refuses to warranty the specified products as required.
   d. Subsequent information that the specified product is unable to perform properly or to fit in the designated space.
   e. In the Engineer's sole judgment, the substitution would be in the Owner's best interest.
5. Revisions to the mechanical system shall be under the supervision of the Engineer at a standard hourly rate charged by the Engineer and shall be paid by the Contractor originating the changes.

1.16 PROTECTION OF EQUIPMENT AND MATERIALS

A. The Contractor shall take such precautions as may be necessary to properly protect his apparatus from damage.

B. This shall include the creation of all required temporary shelters to adequately protect any apparatus above the floor of the construction and the covering of apparatus in the completed building with tarpaulins or other protective covering.

C. Failure to comply with the above to the satisfaction of the Owner's inspector will be sufficient cause for the rejection of the equipment in question and its complete replacement by this Contractor.

D. All apparatus shall be cribbed up from the floor or ground by the Contractor and covered with tarpaulins or other protective covering where necessary or directed.

1.17 FINAL INSPECTION

A. It shall be the duty of this Contractor to make a careful inspection trip of the entire project, assuring himself that the work on the project is ready for final acceptance before calling upon the A/E to make a final inspection.

B. To avoid delay of final acceptance of the work, the Contractor shall have all necessary bonds, warranties, receipts, affidavits, etc., called for in the various articles of these specifications, prepared and signed in advance, together with a letter of transmittal, listing each paper included, and shall deliver the same to the A/E at or before the time of said final inspection. The Contractor is cautioned to check over each bond, receipt, etc., before preparing for submission to verify that the terms check with the requirements of the specifications.

1.18 ASBESTOS

A. No asbestos or asbestos containing materials shall be permitted in this project.

1.19 CUTTING AND PATCHING

A. All Subcontractors shall notify the General Contractor sufficiently ahead of construction of any floors, walls, ceiling, roof, etc., of any openings that will be required for his work.

B. He shall see that all sleeves required for his work are set at proper times so as to avoid delay of the job.

C. All necessary cutting of walls, floors, partitions, ceilings, etc., as required for the proper installation of the work under this Contract shall be done at the Subcontractor's expense in a neat and workmanlike manner, and as approved by the A/E.

D. No joists, beams, girders or columns shall be cut by any Contractor without first obtaining written permission of the A/E.

E. Patching of openings and/or alterations shall be provided by the General Contractor.

F. All openings in firewalls and floors shall be completely sealed after installation for a completely airtight installation. Sealing material shall be non-combustible and UL approved. The installed sealing assembly shall not cause the fire rating of the penetrated structure to be decreased.

G. All openings in exterior walls shall be sealed watertight.

1.20 IDENTIFICATION

A. Refer to Section 23 05 53.

1.21 MANUFACTURER'S INSTRUCTIONS

A. All equipment and devices shall be installed in accordance with these plans and specifications, manufacturer's instructions and applicable codes.

B. Where specifications call for installation of a product to be in accordance with manufacturer's instructions and/or where manufacturer's instructions are required for installation of a product, it shall be the contractor's responsibility to obtain the necessary applicable manufacturer's instructions and install the product in accordance with the manufacturer's instructions.

C. It shall be the Contractor's responsibility to install all equipment, materials, and devices shown on the plans and as called out in these specifications even if manufacturer's instructions are absolutely unattainable.

1.22 RELATED WORK

A. Whether specifically identified or not, it is the responsibility of the Mechanical Contractor to coordinate all mechanical work with all related trades.

1.23 ELECTRICAL WIRING AND EQUIPMENT FOR MECHANICAL SYSTEMS

A. All wiring, conduit, boxes, equipment (controls, thermostats, relays, contactors, motor starters, heaters, switches) and any other control devices or equipment required to form a complete and properly operating system, shall be the responsibility of the Mechanical Contractor.

B. The Electrical Contractor shall only provide line voltage (including hook-up) to all mechanical equipment.

C. All mechanical controls and devices shall be low voltage unless otherwise noted or shown on the plans. Where line voltage controls or devices are noted, the Contractor shall provide complete wiring diagrams (approved by the Engineer) to the Electrical Contractor prior to final hook-up.

D. All electrical resistance heating elements which are scheduled to be served by three-phase electrical power shall impose an equal electrical load on all phases. Electrical resistance elements which are not balanced over all three phases are not acceptable.

E. The Mechanical and Electrical plans are based on the equipment and devices scheduled as shown on the plans or as called for in the specifications. Should any mechanical equipment or device be changed or approved from those which are shown or noted, all electrical and/or mechanical changes shall be made at the expense of the trade or contractor initiating the change with no expense to the Owner, Architect, Engineer or their representatives.

F. All wiring provided by this Contractor shall be installed in a workmanlike manner using tie wraps, labels, anchors and etc. Loose wiring is not acceptable.

G. All conduit and boxes required in all walls for control purposes (thermostats, etc.) shall be provided by electrical contractor. All conduit required in attic, clear spaces, or on roof shall be by mechanical contractor.

1.24 DEMOLITION AND REMODEL

A. It shall be the responsibility of this Contractor to see that all demolition and remodeling work involving his trade (including but not limited to chilled and hot water piping used for space cooling and heating, condensate lines, air handlers, mechanical equipment, etc.) is accomplished in a manner and completeness to provide the appearance of new construction work.

B. Abandoned air conditioning units shall be removed and disposed of off-site in a legal manner.

C. Any usable equipment and/or structure damaged during demolition and remodel work shall be replaced.

D. All abandoned and/or otherwise unused piping shall be securely capped using materials of the same composition as the original piping.

E. No exposed piping and/or other materials will be permitted in the finished job.

F. Any abandoned piping which penetrates the slab in an exposed area shall be securely capped below the slab.

1.25 OPERATION PRIOR TO COMPLETION

A. When any piece of mechanical or electrical equipment is operable and the Contractor needs to operate the equipment, he may do so providing that he properly supervises the operation.

B. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner.

C. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all punch list items before final acceptance by the Owner.

D. The date of acceptance and the start of the warranty may not be the same date.

1.26 SAFETY GUARDS

A. Contractor shall furnish and install all safety guards required. All belt driven equipment, projecting shafts and other rotating parts shall be enclosed or adequately guarded.

1.27 FLAME SPREAD PROPERTIES OF MATERIALS

A. All materials and adhesives used for air conditioning filters, acoustical lining and insulation shall conform to NFPA and UL life and flame spread properties of materials.

B. The composite classifications shall not exceed the flame spread rating and the smoke development rating as outlined by NFPA 255/ ASTM E-84 for the basic material, the finishes, adhesives, etc., specified for each system, and shall be such when completely assembled.

1.28 FILTER ASSEMBLIES

A. All filter housings and assemblies shall be factory built and supplied with the unit. A separate filter rack may be required and is the responsibility of the mechanical contractor to provide.

B. Access doors (panels) which must be opened to change the air filters shall be labeled "Filter Access" and the number and size of required filters shall be identified.

C. No piping conduit etc. shall be installed in front of this access door.

D. Install clean filters prior to substantial completion.

E. All air handlers shall have filters installed upstream of all coils.

1.29 LEAD MATERIALS

A. No lead or lead containing materials shall be allowed in any domestic or potable water supply piping, valves, fixtures, components, equipment or any other item.

1.30 REFRIGERANTS

A. Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs) shall not be allowed in any equipment on this project.

B. Comply with ASHRAE Standards 15 and 34.

1.31 REFRIGERANT RECOVERY AND RECYCLE

A. Refrigerants shall not be released to the environment.

B. Contractor shall provide recovery and recycle equipment that has been certified by the Electrical Testing Laboratories or Underwriters Laboratories.

C. Contractor shall also provide properly trained and certified (in accordance with EPA) personnel for refrigerant work during installation, demolition, start-up, servicing, etc.

1.32 ACCESS CLEARANCE

A. Proper access to all installed equipment shall be provided. The Mechanical Contractor shall label all points of access immediately upon installation with a marker pen.

B. A minimum of 3 feet shall be maintained in front of all access points.

C. If another trade violates this space, the Mechanical Contractor shall immediately notify the General Contractor to correct this condition.

D. When equipment is installed above lay-in ceiling the Mechanical Contractor shall coordinate with the Ceiling Contractor to provide access without removing part of T-bar ceiling.

E. No speakers, lights, fire alarm equipment, etc. shall be installed in lay-in ceiling tiles where access is to be gained.

PART 2 PRODUCTS

A. Not Applicable

PART 3 EXECUTION

3.1 TESTING

A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation regardless of the season the contractor shall test all HVAC equipment in both heating and cooling modes.

B. Each and every phase of the new air conditioning, heating and ventilating systems shall be operated separately, or in conjunction with the other, for a period of time, to demonstrate to the satisfaction of the A/E the ability of the equipment to meet the capacity and performance requirements while maintaining design conditions in accordance with the true intent and purpose of these specifications.

C. Previous to such performance tests, the Contractor shall have set all valves, dampers, motors, controllers, thermostats, etc., and shall have the system operating and maintaining design temperatures, humidity and air circulation throughout all areas of the building.

D. Make adjustments as required to ensure proper functioning of all systems.

E. Special tests on individual systems are specified under individual sections.

F. See Section 23 05 93 for Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

SECTION 23 00 90

HVAC SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This section supplements Division 01 Submittal Procedures and contains additional requirements applicable to Division 23 submittals.

1.2 SECTION INCLUDES

A. This section includes, but is not limited to:
   1. HVAC submittal procedures
   2. List of required Division 23 submittals to the engineer
   3. This section applies only to the Division 23 specifications. Submittals required by other specification divisions are not included here, even though the same subcontractor may be providing work under other divisions.

1.3 RELATED SECTION

A. Division 01 - Submittal Procedures

1.4 DEFINITIONS

A. Product Data: Illustrations, standard schedules, performance charts, instructions, and brochures furnished by the contractor, subcontractor, manufacturer, or supplier to illustrate materials or equipment or to illustrate some portion of the work. Provide a summary of scheduled items with all data in schedules.

B. Shop Drawings: Drawings, diagrams, schedules and other data specifically prepared for the work by the contractor, subcontractor, manufacturer, or supplier to illustrate some portion of the work.

C. Equipment/Material Submittal Package: A compilation of the product data, shop drawings, and other items as required by the specifications, submitted near the start of the work. Typically, the specifications require the initial submittal package to be submitted within a certain number of days after the work starts.

D. Quality Assurance Submittal: Items submitted before and during the execution of a particular portion of the work for the purpose of guarding against defects and deficiencies.

E. Quality Control Submittal: Items submitted at the completion of a particular portion of the work for the purpose of evaluating completed activities and elements of the work for conformance with contract requirements (e.g. start-up reports).

F. Closeout Submittals: Items submitted at or near the completion of the contract.

1.5 SUBMITTALS

A. The materials, workmanship, design, and arrangement of all work installed under this contract shall be subject to the review of the architect, engineer and owner.

B. Manufacturers: Manufacturers submitted shall be as per the acceptable manufacturers listed in each specification section or referenced schedule. For additional manufacturers requiring approval, reference the Substitution of Products article in Section 23 00 00.

C. Required Submittals: Refer to the Submittals article of each individual Division 23 specification section for the required items to be submitted.

D. Contractor's Coordination Submittals: The contractor may require his subcontractors to provide drawings, setting diagrams, and similar information to help coordinate the project, but such data shall remain between the contractor and his subcontractors and will not be reviewed by the engineer.

E. Electronic Submittals: E-mail or other electronic forms of submittals from the contractor are required. The procedures described in this section shall be as follows:
   1. The contractor shall supply one electronic copy of the submittal.
   2. The electronic files will either be e-mailed to the architect, or posted to a project management and information exchange web site, depending on the architect's requirements. The architect and contractor can distribute copies of the files as desired.
   3. The engineer will retain an electronic copy of the submittal and all responses.

F. Coordination Correspondence: The contractor may desire to verify the acceptability of a particular item prior to assembling the initial submittal package. The contractor may send material directly to the engineer for comments and feedback. This communication will be treated as normal coordination correspondence and will not be tracked or documented as a formal submittal. The engineer may or may not respond to such correspondence. If the engineer agrees, in writing, to the use of a particular item, then that same material shall be included in the initial submittal package along with a copy of the correspondence.

G. Unapproved Products: If materials or equipment are installed before being reviewed by the engineer, the contractor shall be liable for the removal and replacement of such unapproved materials and equipment, at no additional expense to the owner. Additionally, if the removal and replacement of rejected materials or equipment necessitates the removal and replacement of other related materials or equipment, then the contractor shall be liable for the removal and replacement of the related materials and equipment at no additional expense to the owner.

H. Product Data: Where the content of manufacturer submittal literature includes data not pertinent to the submittal, clearly indicate which portions of the contents are being submitted for review. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested shall be specific and identifications in catalog, pamphlets, etc., of items submitted shall be clearly made in a contrasting ink or highlighting. Data of a general nature shall not be acceptable.

I. Shop Drawings:
   1. Scale and measurements: Make shop drawings accurately to a scale sufficiently large to show all pertinent aspects of the item.
   2. Electronic shop drawing submittals are required.

PART 2 PRODUCTS

A. Not applicable

PART 3 EXECUTION

3.1 SUBMITTALS

A. Make submittals of product data, shop drawings, samples, quality assurance submittals, quality control submittals, and other items in accordance with the requirements of this section, applicable sections in Division 23, and additional requirements of each individual Division 23 specification section.

B. Grouping of Submittals:
   1. The submittal package shall be coordinated and included in a single submission. Multiple submissions are not acceptable except where prior written approval has been obtained from the engineer. Partial submittals may be rejected, without being reviewed, as not complying with the provisions of the contract.
   2. In the case that multiple submissions are approved, it is the responsibility of the contractor to maintain and update a submittal check list. The contractor shall ensure that all applicable submittal sections are submitted to the Engineer. If a submittal section is not submitted, it will be considered rejected until reviewed by the Engineer.
   3. If submittal sections are submitted as individual submittal files, the submittal sections will be grouped and returned as one file with one set of submittal responses.

C. Electronic Submittal Organization:
   1. Electronic submittals are to be submitted as a single PDF file. Within the PDF file, each section shall be bookmarked.
   2. Provide an electronic submittal cover sheet that lists at least the following:
      a. Project name
      b. Date
      c. Name and address of architect
      d. Name and address of engineer
      e. Name, address and telephone number of prime contractor
      f. Name, address and telephone number of HVAC contractor
      g. Name, address and telephone number of HVAC supplier
   3. Provide an electronic index sheet listing all items submitted.
   4. The contractor shall call to the attention of the engineer, clouded in the submittal and noted after the index sheet, any instance in which the submittals are known to differ from the requirements of the contract documents.
   5. Organize all required items by specification section. The material for each specification section shall be organized as follows:
      a. Provide an electronic section cover sheet that lists the same information as the submittal cover sheet, plus the specification number and title and the name, address and telephone number of the vendor or vendor's representative, if applicable.
      b. Refer to the individual Division 23 specification sections for any required organization of the submittal material within each submittal section.
      c. Bookmarked sections shall be arranged by specification section number in numerical order.
      d. Submit in accordance with these procedures and procedures described in Division 01 Submittal Procedures.
      e. Submittals not organized as described here may be rejected, without being reviewed, as not complying with the provisions of the contract.

D. Response to engineer's review:
   1. Review comments: Review comments of the engineer will either be shown on the returned sets to the contractor or shown on a document attached to the sets. If the comments are on an attached document, then the engineer will place a note on the submittal referring to the attached comments. In such cases, the engineer's signature will appear only on the attached document. If the attached, signed document becomes physically separated from the submittal, then the submittal will no longer be considered as being a reviewed submittal.

2. Complete rejection: If the submittal is not complete or does not meet the requirements of this specification section, then the engineer may reject the entire submittal and return the submittal without further review or comment. In such cases, the entire submittal shall be completely revised and resubmitted. The resubmittal shall be given a new submittal number and shall be documented and processed as a separate submittal from the original.
3. Held for completion: If the submittal is not complete, but is only missing some minor item, the engineer may, at the engineer's sole discretion, hold the submittal rather than rejecting and returning the submittal. In such cases, the engineer will notify the architect and contractor that the submittal is being held for completion. The contractor will be given a predetermined amount of time to provide the missing item. Upon receipt of the missing item, the engineer will insert the missing item into the submittal package and proceed with the review process.
4. Partial rejection: The engineer may reject only certain portions of the submittal. In such cases, only those rejected portions or items need to be revised and resubmitted.
5. Provide as noted and corrected: The engineer may note a required change to a submitted item, but may not consider the change serious enough to require a resubmittal. In such cases, the engineer will note that the item is to be provided as noted or corrected. In such cases, the contractor may proceed to provide the item. However, if subsequent observations reveal that the noted change was not made, then the contractor shall be liable for removal and replacement of the item at no additional cost to the owner.
6. Reviewed without comment: The contractor may proceed to provide all materials and equipment as submitted.

E. Close-out Submittals:
1. Provide close-out submittals in accordance with the requirements of Division 1.

Section	Submit on the following	1	2	3	4	Arch Sub #
23 05 19	**Meters and Gauges for HVAC Piping**					
	Thermometers					
	Pressure Gauges					
	Flow Meters					
23 05 29	**Hangers and Supports for HVAC Piping and Equipment**					
	Isolation Devices					
	Piping hangers and supports					
23 05 32	**Roof Curbs**					
	Roof curbs					
23 05 53	**Identification for HVAC Piping and Equipment**					
	Label material and attachment method (No adhesives)					
	Sample identification tag(s)					
23 05 93	**Testing, Adjusting, and Balancing for HVAC**					
	Test and Balance Company					
	Sample test and balance forms					
23 07 13	**Duct and Grille Insulation**					
	Insulation thickness and R-value					
23 07 19	**Hydronic Piping Insulation**					
	Insulation type					
	Insulation jacketing type					
	Insulation thickness and thermal conductivity (K)					
23 07 21	**Refrigerant Piping Insulation**					
23 09 23	**Energy Management Control System**					
	Energy Management Controls company					
	Control Devices					
	System configuration drawings					
	Sequences of Operation					
23 09 25	**Variable Frequency Drives**					
	VFD manufacturer					
	Voltage/phase					
	VFD HP size					
23 21 13	**Hydronic Piping, Valves, and Appurtenances**					
	Piping material					
	Valve/ appurtenance manufacturer					
23 21 23	**Hydronic Pumps**					
	Pump Manufacturer					
	Voltage/ phase					
	Pump flow (GPM)					
	Pump head (ft.)					
23 23 00	**Refrigerant Piping**					
	Piping material					
23 31 13	**Metal Ductwork**					
	Ductwork material					
	Type of ductwork					
23 33 33	**Access Doors**					
	Access door material					

Section	Submit on the following	1	2	3	4	Arch Sub #
23 34 16	**HVAC Fans**					
	Fan manufacturer					
	Voltage/ phase					
	Fan CFM					
	Fan static pressure					
23 37 13	**Diffusers, Registers, and Grilles**					
	Grille manufacturer					
23 43 23	**Bipolar Ionization Air Purification System**					
	Bipolar ionization manufacturer					
	Bipolar ionization type					
23 52 33	**Water Tube Boilers**					
	Boiler manufacturer					
	Voltage/ phase					
	Boiler capacity					
	Boiler efficiency					
23 64 23	**Air Cooled Scroll Compressor Chillers**					
	Chiller manufacturer					
	Voltage/ phase					
	Chiller capacity					
	Chiller flow rate					
	Entering/ Leaving water temperatures					
	Refrigerant type					
23 73 13	**Modular Indoor Central Station Air Handling Units**					
	Air handler manufacturer					
	Voltage/ phase					
	Air handler CFM					
	Cooling/ heating capacity					
	Air handling unit options, orientation, and size					
	Entering/ leaving air temperature					
	Entering/ leaving water temperature					
23 73 26	**Dedicated Outdoor Air, Air Handling Units**					
	Air handler manufacturer					
	Voltage/ phase					
	Air handler CFM					
	Cooling/ heating capacity					
	Air handling unit options, orientation, and size					
	Entering/ leaving air temperature					
	Entering/ leaving water temperature					
23 81 19	**Packaged HVAC Units**					
	Unit manufacturer					
	Voltage/ phase					
	Unit capacity					
	Unit options and specifics					
23 81 26	**Split System HVAC Units**					
	Unit manufacturer					
	Voltage/ phase					
	Unit capacity					

Section	Submit on the following	1	2	3	4	Arch Sub #
	Unit options and specifics					
23 81 27	**Small Capacity Split System Units**					
	Unit manufacturer					
	Voltage/ phase					
	Unit capacity					
23 81 46	**Water Source Heat Pump**					
	Unit manufacturer					
	Voltage/ phase					
	Unit capacity					
	Unit options and specifics					
23 82 19	**Fan Coil Units**					
	Unit manufacturer					
	Voltage/ phase					
	Unit capacity					
	Unit options and specifics					
23 82 39	**Electric Unit Heaters**					
	Unit manufacturer					
	Voltage/ phase					
	Unit capacity					

1 - Reviewed
2 - Furnish as corrected in comments, resubmit not required
3 - Revise and Resubmit based on comments
4 - Rejected based on comments

END OF SECTION

SECTION 23 05 19

METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Thermometers

B. Pressure gauges

C. Flow meters

D. Pete's plugs

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

C. Section 23 09 23 - Energy Management Control System

D. Section 23 21 13 - Hydronic Piping, Valves, and Appurtenances

E. Section 23 21 23 - Hydronic Pumps

F. Section 23 33 33 - Access Doors

G. Section 23 52 33 - Water Tube Boilers

1.4 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

PART 2 PRODUCTS

2.1 THERMOMETERS

A. Type:
   1. 9" adjustable angle thermometer

B. Construction:
   1. Temperature range:
      a. Fahrenheit degrees as approved by the Engineer.
   2. Window:
      a. Unbreakable, Heat resistant Acrylic.

3. Furnish with separable socket.
4. Manufacturer/Model:
    a. Trerice
    b. MILJOCO

2.2 PRESSURE GAUGES

A. Type:
    1. 4" dial type pressure gauge

B. Manufacturer/Model:
    1. Trerice
    2. MILJOCO

C. Construction:
    1. Pressure range:
        a. PSI as approved by Engineer.
    2. Cast aluminum case
    3. Double strength clear glass window
    4. Stainless steel movement
    5. Phosphor bronze tube with brass socket
    6. Furnish with a quarter turn lever handle gauge cock.
    7. Accuracy:
        a. 1% of scale range.

2.3 CHILLED/ HOT WATER FLOW METERS

A. Type:
    1. Dual turbine flow meter

B. Manufacturer:
    1. ONICON Model F-1200

C. Construction:
    1. Two contra-rotating axial turbines with electronic impedance-based sensing, and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion.
    2. Output signal 0-15V
    3. Accuracy:
        a. ± 0.5% of rate at calibrated velocity
        b. ± 1.0% of rate over a 10:1 turndown
        c. ± 2.0% of rate over a 50:1 turndown

2.4 CONDENSER WATER FLOW METERS

A. Type:
    1. Insertion electromagnetic flow meter

B. Manufacturer:
    1. ONICON Model F-3500

C. Construction:
    1. Wetted metal components to be 316SS.
    2. Meter shall average velocity readings from two sets of diametrically opposed electrodes
    3. Output signal 0-10V
    4. Accuracy:
        a. ± 1.0% of rate from 2-20ft/s

2.5 PETE'S PLUGS

A. Provide two sets of suitable pressure and temperature gauges for use with the plugs.

PART 3 EXECUTION

3.1 INSTALLATION

A. Furnish and install thermometers, pressure gauges and Pete's plugs where indicated on plans in accordance with manufacturer’s instructions.

B. Install thermometers at each pump, and on the return water piping of chilled water and hot water systems.

C. Install pressure gages across each pump.

D. Flow meters shall be installed per manufacturer’s instructions. Particular attention to be paid to upstream and downstream straight pipe runs. Coordinate exact installation location with engineer.

E. Provide 10 extra Pete’s plugs as located by test and balance and controls companies.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Isolation pads

B. Concrete bases

C. Expansion joints

D. Chilled water, Hot water, and Refrigerant Piping supports

E. Other supports

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 09 23 - Energy Management Control System

C. Section 23 21 23 - Hydronic Pumps

D. Section 23 31 13 - Metal Ductwork

E. Section 23 34 16 - HVAC Fans

F. Section 23 52 33 - Water Tube Boilers

G. Section 23 64 23 - Air Cooled Scroll Compressor Chillers

H. Section 23 73 26 - Dedicated Outdoor Air, Air Handling Units

I. Section 23 81 26 - Split System HVAC Units

J. Section 23 81 46 - Water Source Heat Pump Units

1.4 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all items specified in this section in accordance with Section 23 00 90, General Conditions, and Division 1.
   2. Submit shop drawings and catalog data with locations of use.

1.5 REFERENCES

A. Refer to Section 23 00 00 for complete names of references identified in this section.

B. SMACNA Standards

C. ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers

1.6 QUALITY ASSURANCE

A. Isolation devices must be provided by a company whose sole business is to provide isolation equipment.

B. All equipment and materials to be installed in workmanlike manner by experienced mechanics and as recommended by the manufacturers.

C. Design Data: Complete design of isolation equipment including confirmation that no noise will be transmitted to structure of building.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide isolation and support devices as required for all mechanical equipment.

2.2 MANUFACTURERS

A. Amber/Booth

B. Anvil

C. Kenetics

D. Korfund Vibration Mountings

E. Mason

F. Peabody

G. Vibro Acoustics

2.3 CONDENSING UNIT ISOLATION

A. Provide isolation pad between unit and structure as shown on plans.

2.4 FLEXIBLE DUCT CONNECTIONS

A. Use "Ventglas" fabric, fireproof, waterproof, and mildew resistant, approximately 30 ounces per square yard.

B. Comply with SMACNA standards.

2.5 BASE MOUNTED PUMP ISOLATION

A. Provide isolation pads per manufacturer's recommendations or as detailed on plans.

B. Provide vibration isolation expansion joints at all inlets and outlets of pumps.

2.6 ISOLATION FOR AIR HANDLERS ABOVE 5 TONS

A. Spring isolators:
   1. Type:
      a. Open stable steel spring type with a minimum deflection of one inch.

B. Concrete Pad:
   1. Type:
      a. 5 inch housekeeping pad

2.7 HVAC PIPE SUPPORTS

A. Hangers:
   1. All Copper Piping
      a. Copper plated ferrous hangers.
   2. 2" and smaller piping in walls:
      a. May be split cast ring type with fastening device in walls and chases.
   3. All Other Above Ceiling Locations:
      a. Adjustable clevis type. Hangers to accommodate circumference of pipe and saddles.

B. Hanger Rods:
   1. Type:
      a. Minimum 3/8 inch diameter with machine threads.

C. Minimum Steel Hanger Rod Diameter for Individually Suspended Horizontal Pipes:
   1. 2" and smaller diameter pipe:
      a. 3/8"
   2. 2-1/2" to 3-1/2" diameter pipe:
      a. 1/2"
   3. 4" to 5" diameter pipe:
      a. 5/8"
   4. 6" diameter pipe or larger:
      a. 3/4"

2.8 SLEEVES

A. Application:
   1. Provide sleeves for all pipes and conduits which pass through a concrete slab, masonry wall/concrete wall, roof or other portion of the building structure.

B. Above Grade and/or dry locations:
   1. Material:
      a. 20 or 22 gauge galvanized steel.
   2. Size:
      a. As necessary to allow free passage of the insulated pipe.

C. Passing through fire-rated enclosures:
   1. Material:
      a. Galvanized or black steel pipe.
      b. Non-combustible.
      c. PVC will not be allowed.

PART 3 EXECUTION

3.1 ISOLATION DEVICES AND PAD INSTALLATION

A. Install isolation pads between floor and equipment pads according to manufacturer's recommendations and approved shop drawings.

B. Install flexible duct connections where ducts connect to fans or air handling units.

C. All joints to be airtight.

D. Provide a minimum of 1/2" slack in connections, and a minimum of 2½" distance between the edges of ducts.

E. Comply with recommendations of ASHRAE for the selection and application of vibration materials and units.

3.2 SECURING AND SUPPORTING OF HVAC PIPING

A. Support all pipe from the building structure by means of approved hangers and supports while maintaining required grade and pitch, preventing vibration and providing for expansion and contraction.

B. Secure all hangers to approved inserts wherever possible.

C. Set hanger inserts in place when the concrete is poured.

D. If Joists Are Used for Attachment:
   1. 2" diameter or smaller:
      a. May be attached to the bottom of joists.
   2. Greater than 2" diameter:
      a. Must be attached to the top cord of the joists.
   3. Do not support any piping and trapeze hangers from joist bridging on roof and floor deck.

E. If Structural Steel Framing Is Used for Attachment:
   1. Use approved beam clamps.
   2. Where required, install channels to span between framing members.
   3. Do not attach hangers to the roof deck or cross bracing.

F. Hanger Spacing:
   1. Schedule 40 Black Steel Piping (Chilled water/ Hot water piping):
      a. 1/2" diameter pipe → 6'-0" or less
      b. 3/4" diameter pipe → 8'-0" or less
      c. 1-1/4" diameter pipe → 10’-0” or less
      d. Vertical:
         (1) Every Floor Level Minimum
         (2) Adequately support at their bases, either by a suitable hanger placed in the horizontal line near the riser, or by a base fitting set on a pedestal or foundation.
         (3) Support from each floor slab by means of an approved clamp-type support which bears on the slab or beam.
   2. Copper Piping (Refrigerant Piping):
      a. Smaller Than 1¼” → 6'-0" or less
      b. 1 ½” and Larger → 10'-0" or less
      c. Vertical → 10'-0" or less

G. Change of Direction:
1. Install supports within two feet of change of direction.
2. Brackets of approved type may be used along the walls.
3. Install hangers within 2 feet of each change in vertical or horizontal direction, pipe tees and on each side of valves, strainers, etc.
4. Multiple horizontal pipes, smaller than 12" diameter pipe, may be supported on trapeze hangers. Space trapeze hangers in accordance with the schedule for pipe spacing based upon the smallest size pipe.
5. Properly size the trapeze members for the piping load they are to support. The number of pipes on the trapeze must be approved by the Engineer to prevent overloading of the building structure.
6. Where pipes are insulated, oversize the hanger accordingly to accommodate the outside diameter of the insulation. Provide half-round 16 gauge galvanized steel shields, not less than 12" long and rolled to fit the insulation diameter, between the insulation and the hanger.
7. When pipe is guided at top and bottom, cover the entire pipe circumference with metal shields.
8. Adhere metal shield to the insulation so that the metal will not slide with respect to the insulation.
9. Wood struts shall not be used to support piping in walls.

3.3 SLEEVES

A. Above Grade and/or Dry Locations:
1. Walls:
a. Mount flush on both sides.
2. Floors:
a. Mount 2 inches above finished floor in pipe chases.

B. Passing Through Fire-Rated Enclosure:
1. Fill the void space around the pipe in accordance with NFPA requirements.
2. Do not allow the sleeve installation to lower the fire rating of the assembly.

END OF SECTION

SECTION 23 05 32

ROOF CURBS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Roof curbs for rooftop packaged HVAC units, exhaust fans, and supply fans.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 34 16 - HVAC Fans

C. Section 23 81 19 - Packaged HVAC Units

1.4 REFERENCES

A. ASTM D4586 - Fibrated Asphalt Roof Cement

1.5 SUBMITTALS

A. Product Data:
   1. Submit manufacturer's product data sheets, including installation instructions, in accordance with Section 23 00 90, General Conditions, and Division 01.
   2. Submit with equipment that curb is used with.

B. Shop Drawings:
   1. Submit for prefabricated equipment supports in accordance with Section 23 00 90, General Conditions and Division 01.

PART 2 PRODUCTS

2.1 ROOF CURBS FOR ROOFTOP PACKAGED HVAC UNITS

A. Insulated and Non-insulated Roof Decks:
   1. Type - Prefabricated non insulated curb
   2. Material - Minimum 18 gauge prime galvanized steel.
   3. Construction:
      a. Designed to meet local wind zone load/rating
      b. Designed to support full weight of the rooftop unit.
      c. Seal between bottom of unit and curb with gasket.
      d. Factory welded or hinged corners.
      e. Internally reinforced
      f. Factory installed 1” x 4” treated wood nailers fastened from the underside with TEK screws.

g. Top of all curbs to be level with pitch built into the curb when deck slopes ¼" per foot or greater.
h. Full perimeter curbs only.
i. Curbs higher than 18" and curbs for sloped roofs shall have factory welded corners.

4. Height - 18 inches above the roof deck or as shown on plans.
5. Manufacturers:
   a. HVAC unit manufacturer
   b. TECO Metal Products
   c. ThyCurb
   d. Rooftop Systems

B. Roof Curbs for Metal Roofs:
1. Type - Prefabricated insulated curb.
2. Material - Same as roof material.
3. Construction:
   a. Designed to meet local wind zone load/rating
   b. Designed to support full weight of rooftop unit.
   c. Welded corners and seams joined by continuous welds. Add Cricket if curb is wider than 16-inches.
   d. Internally reinforced.
   e. Top of all curbs to be level with pitch built into the curb when deck slopes ¼ inch per foot or greater.
   f. Contractor to span minimum 2 seams, whenever possible. Flanges cannot terminate at seams
4. Fiberglass Insulation:
   a. Thickness - 1 ½ inches
   b. Density - 3 lbs.
   c. Factory installed.
5. Manufacturers:
   a. HVAC unit manufacturer
   b. TECO Metal Products
   c. ThyCurb
   d. Rooftop Systems

2.2 ISOLATION DEVICES

A. Where required on the drawings, the unit shall be mounted on a spring isolation curb. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 1/4"(6 mm) thick. Steel springs shall be laterally stable and rest on 1/4"(6 mm) thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2"(50 mm) of insulation. Curb shall be type RSC as manufactured by Mason Industries, Inc. or approved equal.

2.3 ROOF CURBS FOR EXHAUST AND SUPPLY FANS

A. Insulated and Non-insulated Roof Decks:
1. Type - Prefabricated insulated curb.
2. Material - Minimum 18 gauge prime galvanized steel.

3. Construction:
    a. Designed to meet local wind zone load/rating
    b. Designed to support weight of the exhaust or supply fan.
    c. Factory-welded or hinged corners.
    d. Internally reinforced.
    e. Factory-installed 1” x 4” treated wood nailers fastened from the underside with TEK screws.
    f. Top of all curbs to be level with pitch built into the curb when deck slopes ¼ inch per foot or greater.
4. Fiberglass Insulation:
    a. Thickness - 1 ½ inches
    b. Density - 3 lbs.
    c. Factory installed.
5. Height - 18 inches above the roof deck or as shown on plans.
6. Manufacturers:
    a. TECO Metal Products
    b. ThyCurb
    c. Rooftop Systems
    d. Fan Manufacturer

B. Roof Curbs For Single-Ply Roofing:
1. Type - Prefabricated insulated curb.
2. Material - Minimum 18 gauge prime galvanized steel.
3. Construction:
    a. Designed to meet local wind zone load/rating
    b. Designed to support weight of the exhaust or supply fan.
    c. Welded corners and seams joined by continuous welds.
    d. Internally reinforced.
    e. Factory-installed 2” x 4” treated wood nailers fastened from the underside with TEK screws.
    f. Top of all curbs to be level with pitch built into the curb when deck slopes ¼ inch per foot or greater.
4. Fiberglass Insulation:
    a. Thickness - 1 ½ inches
    b. Density - 3 lbs.
    c. Factory installed.
5. Height - 16 inches above roof deck or as shown on plans.
6. Manufacturers:
    a. Fan manufacturer
    b. TECO Metal Products
    c. ThyCurb
    d. Rooftop Systems

C. Roof Curbs for Metal Roofs:
1. Type - Prefabricated insulated curb.
2. Material - Same as roof material.
3. Construction:
    a. Designed to meet local wind zone load/rating
    b. Designed to support weight of the exhaust or supply fan.
    c. Welded corners and seams joined by continuous welds. Add Cricket if curb is wider than 16-inches.
    d. Internally reinforced.
    e. Top of all curbs to be level with pitch built into the curb when deck slopes ¼ inch per foot or greater.
    f. Contractor to whenever possible span minimum 2 seams. Flanges cannot terminate at seams

4. Fiberglass Insulation:
    a. Thickness - 1 ½ inches
    b. Density - 3 lbs.
    c. Factory installed.
5. Height - 16 inches above roof deck or as shown on plans.
6. Manufacturers:
    a. Fan manufacturer
    b. TECO Metal Products
    c. ThyCurb
    d. Rooftop Systems

D. Kitchen Exhaust Fan Curb:
1. Designed to meet local wind zone load/rating
2. All kitchen exhaust fans to have extended vented curb extension.

2.4 RELATED MATERIALS

A. Nails:
1. Type:
    a. Stainless steel, flathead, wire, barbed, slating type.
2. Washers:
    a. Neoprene.

B. Flashing Cement:
1. ASTM D4586 - Type 1
2. Asbestos free

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrates are smooth and clean to extent needed for work.

3.2 INSTALLATION

A. General:
1. Install prefabricated roof curbs beneath new exhaust fans, supply fans, and all other mechanical equipment on the roof.
2. Install work watertight, without waves, warps, buckles, fastening stresses or distortion.
3. Allow for expansion and contraction.
4. Coat contact surfaces of dissimilar metals with zinc chromate paint.
5. Set LEVEL and square on structural framing beneath roof deck.
6. Securely fasten curb flanges with bolts through flanges.
7. Seal bolt heads with flashing cement.

B. Roof Curbs for Rooftop Packaged HVAC Units:
1. Roofing contractor to install 1½ inch, 3 lb. density fiberglass insulation between unit and roof deck.
2. Roofing material is not to be placed over top of curb.

C. Roof Curb Heights:
1. Verify roofing insulation thickness where curbs are to be installed. Coordinate height above roof to meet roofing manufacturer's specifications.

2. Minimum Height:
   a. 12-inches above finished roof.

END OF SECTION

SECTION 23 05 33

ROOF CURB ADAPTERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Roof curb adapters for packaged rooftop HVAC units and roof mounted fans.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 34 16 - HVAC Fans

C. Section 23 81 19 - Packaged HVAC Units

1.4 REFERENCES

A. ASTM A-446, 525, and 527

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data sheets, including installation instructions, in accordance with Section 23 00 90, General Conditions, and Division 1.

B. Shop Drawings: Submit for prefabricated equipment supports in accordance with Section 23 00 90.

PART 2 PRODUCTS

2.1 ROOF CURB ADAPTERS FOR PACKAGED ROOFTOP HVAC UNITS AND ROOF MOUNTED FANS

A. Type: Prefabricated insulated, self-contained curb adapters.

B. Material: Minimum 18 gauge prime galvanized steel.

C. Construction:
1. Designed to support weight of the equipment.
2. Welded corners.
3. Seams joined by continuous water and airtight welds.
4. Include necessary block-offs to allow use of existing ductwork.
5. Insulated and internally reinforced with T-bars 36" on center.

D. Manufacturer/Model:
1. HVAC Manufacturer
2. ThyCurb

3. TECO Metal Products
4. Rooftop Systems

E. Contractor and manufacturer to verify all existing rooftop units and roof mounted fans. Contractor and manufacturer shall ensure proper fit between existing rooftop equipment base and new rooftop unit and fabricate curb adapter so that any slope in the existing roof curb is accounted for, and all equipment is installed level.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrates are smooth and clean to extent needed for work.

3.2 INSTALLATION

A. General:
1. Install prefabricated roof curb adapters securely between new equipment and old roof curbs.
2. Install work watertight, without waves, warps, buckles, fastening stresses or distortion.
3. Allow for expansion and contraction.
4. Coat contact surfaces of dissimilar metals with zinc chromate paint.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Identification required for mechanical systems.

B. Code required identification not shown on plans nor specified herein shall be provided.

1.3 RELATED SECTION

A. Section 23 00 00 - Basic Mechanical Requirements

1.4 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

B. Submit wording of nameplates with submittals.

C. Submit list of all products incorporated in this section.

1.5 REFERENCES

A. Comply with ANSI A13.1

B. USAS Code B31.8

C. NTSB-PSS-73-1

D. AGA

1.6 DESCRIPTION OF WORK

A. Nameplates and tags are to be provided for all mechanical equipment and piping in the project. Identification is also required for the following, but is not limited to:
   1. Air Handlers
   2. Boilers/Water Heaters
   3. Condensing Units
   4. Duct Dampers
   5. Filter Sizes for Air Handlers
   6. Fire Dampers
   7. Heat Exchangers
   8. Outside Air Units
   9. Piping
   10. Pumps
   11. Starters

12. Supply/Exhaust Fans
13. Valves

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Seton

B. Brady

C. MSI

2.2 EQUIPMENT LABELS

A. Type: Engraving-Stock, melamine plastic laminate, 3 layer.
   1. Thickness:
      a. Less than 25 square inches: 1/16 inch
      b. 25 square inches or more: 1/8 inch

B. Color:
   1. Black

C. Conform to FS L-P-387A

2.3 LETTERING

A. Style:
   1. Engraved standard print.

B. Size:
   1. 3/16 inch to 1/4 inch

C. Color:
   1. White letters, black background

2.4 NAMEPLATE/TAG INFORMATION

A. HVAC Equipment:
   1. Unit mark from Drawings/Owner
   2. Voltage - Phase
   3. Manufacturer and Model Number
   4. Filter size

2.5 NAMEPLATE FASTENERS

A. Securely attach nameplates to equipment with non-corroding stainless steel screws.

B. Non-corroding pop rivets are acceptable.

C. Stick-ons or adhesives will not be allowed.

2.6 PIPING AND CONTROL DIAGRAM SIGNS

A. Material: 1/4 inch acrylic cover and backing screwed together with brass screw/bolts.
   1. Size:
      a. Minimum: 12" x 17"
      b. Maximum: 24" x 36"

B. Provide a diagram in each mechanical room similar to the diagrams shown on the plans, and/or as required for the area served. This diagram to reflect as built conditions.

2.7 IDENTIFICATION OF PRODUCTS

A. Provide pipe markers with the following features.
   1. Letters from 1/2" to 3-1/2"; size letters to afford readability from the appropriate viewing position.
   2. Repeated and reversed words for viewing from 360^{o} around pipe.
   3. Self-clinging, coiled markers that snap into place around pipe and do not require any other securement.
   4. Integral directional arrows.

B. Letters on Field:
   1. Identify the specific material conveyed. (i.e. "Domestic Cold Water", "Sprinkler", etc.)

C. Model:
   1. Less than 3/4":
      a. Tags: Piping System Devices, color codes for hazard.
   2. 3/4" up to 6"; snap-on.
   3. Over 6"; strap-on, with stainless steel spring straps.
   4. Use tags and/or nameplates that are scratch resistant and UV resistant for outdoor equipment and piping.

D. Piping System Devices (Valves, Thermometers, Pressure Gages, etc., and Pipe Less Than 3/4"):
   1. Identify with the following:
      a. Tags:
         (1) Not less than 1-1/2 inch brass or aluminum tags, round, square, or octagonal.
      b. Stamp tags with minimum 1/2" high descriptive characters, 1/2" high numbers with black enamel-filled indentations.

E. Attachment:
   1. Stainless steel or solid brass jack chain, or stainless steel or brass "S" hooks

F. Ductwork:
   1. Stenciled letters or self-adhesive labels, minimum 1" high characters.
   2. Red ribbon at each balancing damper.

G. Underground Warning Tapes:
   1. Provide materials that meet the codes or have the approvals listed below:
      a. Office of Pipeline Safety Regulation, USAS Code B31.8.
      b. GSA Public Building Service Guide Specification.
      c. National Transportation Safety Board Report NTSB-PSS-73-1.
      d. AGA Report 72-D-56.
      e. API Report API RP 1109.
   2. Material:
      a. Plastic, continuous tape, color-coded, marked for hazard.

b. For Non-metallic Piping System:
(1) Aluminum foil core encased in plastic.
c. Metallic Piping:
(1) Plastic tape.

3. Color:
a. Colored (not printed color) plastic, coded for material conveyed by piping.
4. Width:
a. As scheduled for piping system burial depth.
5. Legend:
a. "Caution [System Name] Line Buried Below".
6. Tape Colors:

Utility	**Color**
Natural Gas, Oil, Dangerous Materials	Hi Visibility Safety Yellow
Communications	Safety Alert Orange

7. Model:
a. Metallic Piping System:
(1) Polyethylene Tape.
b. Non-Metallic Piping System:
(1) Metallic Detection Tape.

H. Underground Gas Piping:
1. Attach No. 18 gauge copper tracer wire to the piping and terminate above grade at each end.

I. Pipeline Markers for Pipe Beneath Pavement and Slabs:
1. Minimum 2" round, square, or octagonal, same as specified in Subparagraph: Piping System Devices.

J. Attachment:
1. 1-1/2" screw, bolted to tag as anchor.
2. Anchor Setting Compound:
a. Epoxy or epoxy grout, compatible with the pavement.

PART 3 EXECUTION

3.1 GENERAL

A. Contractor shall verify room numbers with Owner/Engineer before nameplates are fabricated.

B. The following shall be permanently and clearly identified:
1. Each air handler, condensing unit, compressor, exhaust fan, and pump.
2. Each zone duct, outside air duct, and return air duct whose duty is not immediately apparent.
3. Each valve whose service and/or duty is not immediately apparent.

3.2 INSTALLATION

A. Install signs on non-removable panels. Attach to equipment with pop rivets or stainless steel screws.

B. Mount in an easily visible location.

C. All labeling identification shall conform to final room numbers. Coordinate with General Contractor, A/E and Owner to secure construction room numbers.

D. Provide all additional signage required by local authority at no cost to the Owner.

E. Provide filter sizes and quantity on all air handlers.

F. Complete installation in accordance with ANSI A13.1 and manufacturer's installation instructions and with the Drawings. Fasten each unit securely in place with stainless steel screws.

G. Equipment Labeling:
   1. Install on scheduled items of equipment, including the following:
      a. Air conditioning equipment
      b. Pumps
      c. Control panels and major control components
      d. Include Mark Number and descriptive name from Drawing and Specification schedules
      e. Attach with corrosion resistant, stainless steel screws or pop rivets
      f. Install 1/2" diameter adhesive marker (color to be approved by A/E), and apply to T-bar below any mechanical equipment and fire dampers above lay-in ceiling.

H. Piping System Color Coding:
   1. Designate for painter the following:
      a. Types of piping services
      b. Direction of flow
      c. Other information required for proper identification.

I. Surfaces to be Painted:
   1. Bare piping
   2. Insulation covering of insulated piping

J. Paint according to the following schedule:

System	**Pastel Color**
Condenser Water	Green
Gas Piping on Roof	Black or as required by local authority having jurisdiction

K. Piping System Devices (Valves, Thermometers, Pressure Gages, etc.):
   1. Identify with the following information:
      a. System
      b. Device number
      c. Device Function

L. Device Chart:
   1. Key devices to device chart
   2. Give complete description of device function and system.

M. Key devices to drawings as follows:
   1. Floor plans
   2. Schematic drawings of piping systems

N. Underground Warning Tapes:
1. Tape Widths:

Piping Burial	**Depth Tape Width**
10"	2"
20"	3"
27"	6"
30"	9"
40"	12"
50" or more	18"

O. Recommended Tape Bury Depth:
1. Minimum Depth:
   a. 6".
2. Distance Between Pipe and Tape:
   a. Minimum 12".
   b. Maximum Depth: 12".
3. Tie tape to pipe where pipe leaves the ground.

P. Pipeline Markers for Pipe Beneath Pavement and Slabs.
1. Location:
   a. Accuracy:
      (1) Plus or minus 6" from piping centerline.
   b. Flat Edge Pavement and Slabs:
      (1) Set within 6" of pavement or slab edge.
   c. Concrete Curbs:
      (1) Set in top of curb.
   d. Spacing:
      (1) Each change in direction, each edge of pavement or slab, maximum spacing of 100'.
2. Legend:
   a. Same as tags plus an engraved or stamped line; set marker with line parallel to buried line.
3. Attachment:
   a. Drill hole for anchor bolt, full depth of bolt plus 1/2"; set full tag and bolt in epoxy, flush with pavement or slab.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Testing and balancing services for the heating, ventilating, and air conditioning (HVAC) systems of this project.

B. The testing and balancing agency will be responsible for the satisfactory execution of testing and balancing of the HVAC systems.

C. The following are acceptable agencies:
   1. Complete System Balance
   2. Delta-T, Inc.
   3. Engineered Air Balance
   4. PHI Service Agency, Inc.
   5. Air Balancing Company, Inc.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 07 13 - Duct and Grille Insulation

C. Section 23 09 23 - Energy Management Control System

D. Section 23 21 23 - Hydronic Pumps

E. Section 23 31 13 - Metal Ductwork

F. Section 23 34 16 - HVAC Fans

G. Section 23 37 13 - Diffusers, Registers, and Grilles

H. Section 23 52 33 - Water Tube Boilers

I. Section 23 64 23 - Air Cooled Scroll Compressor Chillers

J. Section 23 73 13 - Modular Indoor Central Station Air Handling Units

K. Section 23 81 19 - Packaged HVAC Units

L. Section 23 81 26 - Split System HVAC Units

1.4 STANDARDS

A. The balancing agency shall perform the services specified herein in accordance with the Associated Air Balance Council's National Standards, including revisions, to the date of the contract.

B. All terms in this specification shall have their meaning defined as stated in the National Standards.

C. If these specifications set forth more stringent requirements than the AABC National Standards, these specifications shall prevail.

1.5 QUALIFICATIONS OF THE BALANCING AGENCY

A. The balancing agency shall be a member of the Associated Air Balance Council (AABC) and/or certified by the National Environmental Balancing Bureau (NEBB).

B. To perform required professional services, the balancing agency shall have a minimum of one "Test and Balance Engineer" certified by the Associated Air Balance Council and/or the National Environmental Balancing Bureau (NEBB).

C. This certified "Test and Balance Engineer" shall be responsible for supervision and certification for the total work herein specified.

D. The balancing agency shall submit records of experience in the field of air and hydronic system balancing or any other data as requested by the Owner/Engineer. The supervisory personnel for the firm shall have at least five (5) years' experience, and be a full time employee for a minimum of six (6) months prior to the project. All employees used in this project shall be qualified technicians in this specific field.

E. The balancing agency shall furnish all necessary calibrated instrumentation to adequately perform the specified services. An inventory of all instruments and devices in possession of the balancing agency may be required by the Owner to determine the balancing agency's performance capability.

F. The balancing agency shall have operated for a minimum of five (5) years under its current name.

1.6 DOCUMENTS

A. The General Contractor will provide the balancing agency one copy of the following documents:
   1. Project drawings (mechanical sepias if requested) and specifications.
   2. Reviewed construction revisions pertaining to the HVAC systems.
   3. Reviewed submittal data on HVAC equipment and systems to be installed by the Mechanical Subcontractor.
   4. Reviewed HVAC shop drawings.
   5. Reviewed HVAC wiring diagrams, control diagrams, and equipment brochures, as appropriate.

1.7 COORDINATION

A. It will be necessary for the balancing agency to perform its services in close coordination with the Mechanical Subcontractor.

B. The plans and specifications indicate meters, valves, dampers, and other devices for the purpose of adjusting the system to obtain optimum operating conditions. It will be the responsibility of the Mechanical Subcontractor to install these devices in a manner that will leave them accessible, readily adjustable and complete. The balancing agency shall provide guidance if there is a questionable arrangement of a control or balancing device.

C. The General Contractor, Mechanical Contractor, Temperature Controls Subcontractor, and the suppliers of the HVAC equipment shall all cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components. In addition, they shall furnish all labor and materials required to eliminate any system deficiencies.

1.8 RESPONSIBILITIES OF THE MECHANICAL CONTRACTOR

A. The Mechanical Contractor shall complete the installation and start all HVAC systems to ensure they are working properly, and shall perform all other items as described hereinafter to assist the balancing agency in performing the testing and balancing of the HVAC systems.

B. Air Distribution Systems:
   1. Verify installation for conformity to design.
   2. Terminate all supply, return, and exhaust ducts, and pressure test them, for leakage, as required by specification.
   3. Ensure that all splitters, extractors, and volume and fire dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside, return, relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.
   4. Verify that all supply, return, exhaust, and transfer grilles; registers; diffusers; and high-pressure terminal units are installed and operational.
   5. Ensure that air-handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., are blanked and/or sealed to eliminate excessive bypass or leakage of air.
   6. Ensure that all fans (supply, return, relief, and exhaust) are operating and free of vibration. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protection shall be of proper size and rating. A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating.
   7. Make any necessary changes to the sheaves, belts, and dampers, as required by the balancing agency, at no additional cost to the Owner.
   8. Install clean filters.

C. Water Circulating Systems:
   1. Verify installation for conformity to design.
   2. Check all pumps to verify pump alignment and rotation.
   3. Ensure that systems are clean, with the proper strainer screens installed for normal operation.
   4. Check all pump motors for current and voltage, to ensure that motors do not exceed nameplate rating.
   5. Verify electrical overload protection of proper size and rating.
   6. Ensure that all water circulating systems shall be full and free of air; that expansion tanks are set for proper water level; and that all air vents were installed at high points of systems and are operating.
   7. Check and set operating temperatures of heat exchangers to design requirements.

1.9 RESPONSIBILITIES OF THE TEMPERATURE CONTROLS CONTRACTOR

A. The Temperature-Controls Contractor shall allow sufficient time in the project to provide assistance and instruction to the balancing agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers, or any other

device that may need set points changed so that the testing and balancing work can be performed.

B. Furnish to the balancing agency any software and cables required to make adjustments to controls. Any unique micro-processor required to set controls shall be furnished by Temperature Controls Contractor.

C. The Temperature Controls Contractor shall complete the installation of the temperature control system, and operate and test all control systems to ensure they are functioning properly as designed. The Temperature Controls Contractor shall assist the balancing agency in testing and balancing the HVAC systems, as described hereinafter.
   1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, and fire and freeze-stats.
   2. Verify that all controlling instruments are calibrated and set for design operating conditions.
   3. Calibrate room thermostats/sensors after installation, and before the thermostat control verification tests are performed. The balancing agency shall prove the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.

1.10 PRE-BALANCING CONFERENCE

A. Prior to beginning of the testing, adjusting and balancing procedures, schedule and conduct a conference with the Architect/Engineer, General Contractor, Mechanical Contractor, Electrical Contractor and Temperature Controls Contractor. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.11 NOTIFICATION FOR TESTING AND BALANCING WORK TO BEGIN

A. The general contractor shall notify the balancing agency in writing when all heating, ventilating, and air conditioning systems are complete and ready for testing and balancing. The Mechanical Contractor shall attest that he has completed all items as described in "RESPONSIBILITIES OF THE MECHANICAL CONTRACTOR" Section of these specifications.

B. If, upon commencing the work, the balancing agency finds that the systems are not ready, or if a dispute occurs as to the readiness of the systems, the balancing agency shall request an inspection to be made by the Mechanical Engineer. This inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for testing and balancing. Should the inspection reveal the notification to have been premature, the balancing agency shall be reimbursed for all costs for the inspection and work previously accomplished. Furthermore, such items that are not ready for testing and balancing shall be completed and placed in operational readiness before testing and balancing services shall again be requested.

PART 2 PRODUCTS

A. Not Applicable

PART 3 EXECUTION

3.1 SCOPE

A. In accordance with Project Drawings and Specifications and as specified herein, the balancing agency shall provide all supervision, personnel, instruments, calibration equipment, and all other materials and services necessary to perform all testing and balancing of the heating, ventilating, and air conditioning systems. All test data including all pertinent calculations shall be reported on appropriate forms.

3.2 GENERAL

A. The testing and balancing of the heating, ventilating, and air conditioning systems shall be performed by an independent balancing agency approved by the Engineer. The balancing agency shall have a minimum of five years specialized experience in air and hydronic system balancing, possess calibrated instruments, certified "Test and Balance Engineers", and skilled technicians to perform all required tests. The balancing agency shall be a certified member of the Associated Air Balance Council and/or the National Environmental Balancing Bureau (NEBB).

B. The tests shall demonstrate the specified capacities and operation of all equipment and materials comprising the systems. The balancing agency shall then make available to the Owner's representative such instruments and technicians as are required for spot checks of the system.

C. The balancing agency shall not instruct or direct the Mechanical Contractor in any of the work. Any proposed changes or revision in the work shall be submitted to the Architect and General Contractor in writing.

D. Document Review:
   1. The Test and Balance Firm shall be responsible for reviewing the HVAC plans and specifications relating to the test and balance services for proper arrangement and adequate provisions of devices for testing, adjusting and balancing.
   2. Test and Balance Firm shall review HVAC manufacturers’ submittals data relative to balanceability.
   3. Test and Balance Firm shall review submitted HVAC automatic temperature control sequences for conformity to the specifications.

3.3 SERVICES

A. During construction, the balancing agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the heating, ventilating, and air conditioning systems.

B. The inspections shall be performed periodically as the work progresses. A minimum of two inspections are required as follows: (1) when 60 percent of the duct work is installed; (2) when 90 percent of the equipment is installed. The balancing agency shall submit a brief written report of each inspection to the General Contractor and Engineer.

C. Upon completion of the installation and start-up of the mechanical equipment by the Mechanical Contractor, the balancing agency shall test and balance the system components to obtain optimum conditions in each conditioned space in the building.

3.4 DEFICIENCIES

A. If in the process of performing the TAB work, any deficiencies encountered shall be brought to the attention of the contractor responsible through defined procedures, and entered in the punch list of deficiencies on the next daily Status Report. If correction of the deficiency is

urgent, the matter shall be brought to the attention of all involved parties for quick resolution. The General 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 during the testing, adjusting and balancing period.

B. The notification may be for single or multiple deficiencies. The work necessary to correct items on the listing shall be performed and verified in writing by the affected trade.

C. All deficiencies that prevent proper TAB work from being completed shall be corrected prior to submittal of the Final TAB Report, unless the correction of such deficiencies cannot be accomplished in a reasonable period of time, in which case the Mechanical Engineer may grant permission to submit the Final TAB Report with the deficiencies detailed in the report.

3.5 AIR SYSTEM PROCEDURES

A. The balancing agency shall perform the following testing and balancing functions in accordance with the Associated Air Balance Council's National Standards:
   1. Fan Speeds:
      a. For all multistage units, low and high fan speeds must be individually set.
      b. Test and adjust fan RPM to achieve design CFM requirements.
   2. Current and Voltage:
      a. Measure and record motor current and voltage.
   3. Pitot-tube Traverse:
      a. Perform a Pitot-tube traverse of main supply and return ducts to obtain total CFM. If a Pitot-tube traverse is not practical, the summation of the outlets or inlets may be used. An explanation why a traverse was not made must appear on the appropriate data sheet.
   4. Outside Air:
      a. Test and adjust system minimum outside air by Pitot-tube traverse. If a Pitot-tube traverse is not practical, the percentage of outside air may be determined by calculations from the return air, outside air, and mixed air temperatures. Make allowances for heat of compression and motor heat where applicable.
   5. Static Pressure:
      a. Test and record system static pressures, including suction and discharge static pressure of each fan.
   6. Air Temperature:
      a. Take wet-bulb and dry-bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.
   7. Zone Ducts:
      a. Adjust zone ducts to within design CFM requirements. At least one zone balancing damper shall be completely open.
   8. Main Ducts:
      a. Adjust main ducts to within design CFM requirements and traverse for total CFM quantities.
   9. Branch Ducts:
      a. Adjust branch ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.
   10. Tolerances:
      a. Test and balance each diffuser, grille, and register to within 10 percent of design requirements.

11. Identification:
    a. Identify the location and area of each grille, diffuser, register, and terminal box. This information shall be recorded on air outlet data sheets.
12. Description:
    a. Record the size, type, and manufacturer of each diffuser, grille, and register on air outlet data sheets.
13. Terminal Boxes:
    a. Set volume regulators on all terminal boxes to meet design maximum and minimum CFM requirements. All associated temperature controls shall be checked for proper operation and calibration. If the terminal boxes have separate settings for heating and cooling CFM, the CFM quantities for each shall be recorded on air outlet data sheets. All diffusers connected to the terminal box shall be read in the heating and cooling modes and their readings recorded on air outlet data sheets.
14. Minimizing Drafts:
    a. Adjust all diffusers, grilles, and registers to minimize drafts in all areas.

3.6 CHILLED-WATER AND HOT-WATER PROCEDURES

A. The various water circulating systems shall be filled, purged of air, and put into operation by the Mechanical Contractor before hydronic balancing.

B. The flow of water through all coils shall be adjusted by manipulating balancing valves until the rated pressure drop through the coil or metering device is obtained.

C. The balancing agency shall perform the following testing and balancing functions in accordance with the AABC National Standards:
1. Water Treatment:
    a. Examine the water in the system and determine if the water has been treated and cleaned. If it has not, request the Mechanical Contractor to clean the water and request the Owner to treat the water.
2. Strainers:
    a. Request that the Mechanical Contractor clean all strainers.
3. Valves:
    a. Set all balancing valves and automatic temperature control bypass valves to the full-open position for balancing. For three-way valves, the rated pressure drop shall first be adjusted with the three-way valve set so that all water flows through the coil. The bypass balancing valve shall then be adjusted on each coil until equal pressure drop between supply and return connections is obtained, with the three-way valve set to bypass the coil.
4. Pumps:
    a. Adjust chilled-water, hot water, and condenser-water pump to meet design GPM requirements. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Measure and record operating current and voltage.
5. Central Plant:
    a. Adjust water flow from the central plant, if applicable.
6. Tolerances:
    a. Proceed to balance all chilled-water and hot-water coils within 10 percent of design flow requirements.
7. Marking:
    a. Mark all settings and record all data after completing the flow readings and coil adjustments.

3.7 VERIFICATION OF TEMPERATURE CONTROL

A. The balancing agency shall be assisted by the Temperature Controls Contractor in verifying the operation and calibration of all temperature control systems. The following tests shall be conducted:
   1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, and fire and freeze stats.
   2. Verify that all controlling instruments are calibrated and set for design operating conditions.
   3. Verify the accuracy of the final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.

B. In the process of performing the TAB work, the balancing agency firm shall:
   1. Verify that all dampers, valves and other controlled devices are operated by the intended controller.
   2. Verify that all dampers and valves are in the position indicated by the controller (open, closed, or modulating).
   3. Verify the integrity of valves and dampers in terms of tightness of close-off and of full-open position. This includes dampers in VAV terminals.
   4. Check that all valves are properly installed in the piping system in relation to direction of flow and location.
   5. Verify the proper application of all normally open and normally closed valves.
   6. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold/hot walls.
   7. Check the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media.
   8. Check the sequence of operation for any control mode to ensure that it is in accordance with the Contract Documents.

C. Verify that all controller set points meet the design intent. Record observations of systems under DDC control. Record all default set points if different from operating set points.

D. Check all dampers for free and full operation, record any obstructions.

E. Verify the operation of all interlock systems.

F. Perform all system verifications to assure the safety of the system and its components.

G. Verify that the changeover from heating to cooling mode occurs as specified.

3.8 TEST AND BALANCE REPORT

A. The test and balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed on white bond paper and bound and submitted in a single PDF file. The report shall be certified, accurate and complete by the balancing agency's certified Test and Balance Engineer.

B. The report shall contain the following general data in a format selected by the balancing agency:
   1. Project number
   2. Contract number
   3. Project title
   4. Project location
   5. Project Architect
   6. Project Mechanical Engineer

7. Test & Balance agency
8. Test & Balance Engineer
9. General Contractor
10. Mechanical Subcontractor
11. Dates tests were performed
12. Certification

C. The test and balance report shall be recorded on report forms conforming to the recommended forms in the AABC National Standards. At a minimum, the report shall include:
   1. Preface
      a. A general discussion of the system, any abnormalities and problems encountered.
      b. A deficiency log detailing system abnormalities that do not meet these specifications.
      c. The list of instruments including type, model, manufacturer, serial number, and calibration dates.
   2. Air System Data
      a. All test and balance data indicating design conditions, and actual conditions of operation for each device and/or piece of HVAC equipment.
      b. Outside Air Temperatures, dry bulb and wet bulb.
      c. Entering Air Temperatures, dry bulb and wet bulb.
      d. Discharge Air Temperatures, dry bulb and wet bulb.
      e. Suction and discharge static pressures across each fan.
   3. Water System Data
      a. All test and balance data indicating design conditions, and actual conditions of operation for each device and/or piece of HVAC equipment.
      b. Verification of valve positioning and static pressures across valves
      c. Entering and Leaving water temperatures across all coils.
      d. Static pressure drops across all coils.
      e. Static pressure drops across all equipment (chillers, pumps, boilers, cooling towers, etc.)
   4. System Identification
      a. In each report, the zones, supply, return, and exhaust openings, and traverse points shall be numbered and/or lettered on mechanical drawings to correspond to the numbers and letters used on the report data sheets.
   5. Controls
      a. Document verification of controls.
   6. Occupancy Inspection
      a. Make a total of three (3) inspections within ninety (90) days after occupancy of the building, and make adjustments if required, to ensure that satisfactory conditions are being maintained throughout. Inspections to be coordinated with Architect/Engineer and Owner and shall be documented with a supplemental report containing data and information as required.
   7. Instructions to Operating Personnel
      a. Test and Balance Firm shall instruct the operating personnel regarding the following:
         (1) Systems Operation
         (2) Unusual Operating Conditions.
         (3) System Troubleshooting Procedures.

3.9 REPORT SUBMITTAL

A. The test and balance report are required and shall be submitted to the General Contractor for distribution to the Owner, Architect and Mechanical Engineer. The test and balance report shall be submitted in a single, fully bound PDF file.

3.10 FINAL ACCEPTANCE

A. At the time of final inspection, the balancing agency shall recheck, in the presence of the Owner's representative, specific and random selections of data recorded in the certified test and balance report.

B. Points and areas for recheck shall be selected by the Owner's representative.

C. Measurements and test procedures shall be the same as the original test and balance.

D. Selections for recheck, specific plus random, shall not normally exceed 15 percent of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.

E. If random tests demonstrate a measured flow deviation of 10 percent or more from that recorded in the certified test and balance report, the report shall automatically be rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test and balance report submitted, and a new inspection test made, all at no additional cost to the Owner.

3.11 OPPOSITE SEASON TEST

A. Opposite season test and balance work shall be required for systems that cannot be tested and balanced due to climate or seasonal conditions. An example would be Chiller operation in the winter season, or Boiler operation in the summer season. In such case, the balancing agency shall perform an inspection of the buildings HVAC system during the opposite season from that in which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation in compliance with the contract documents. The TAB agency shall contact the Owner’s Commissioning Agent, to coordinate such work, no less than 14 calendar days prior to any Opposite Season Testing.

B. Opposite Season Testing is not required if the Owner’s Commissioning Agent can simulate off season conditions via the building automated controls system.

END OF SECTION

SECTION 23 07 13

DUCT AND GRILLE INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. External duct insulation

B. Internal duct liner

C. Exterior ductwork

D. Kitchen exhaust duct

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 31 13 - Metal Ductwork

C. Section 23 37 13 - Diffusers, Registers, and Grilles

1.4 SUBMITTALS

A. Product Data:
1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 01.
2. Submit product data indicating typical catalog of information.
3. Submit product data sheets indicating dimensions, general assembly, and ratings.
4. Submit manufacturer's installation instructions.
5. Submit kitchen exhaust duct wrap to City for approval prior to submitting to Engineer.

1.5 REFERENCES

A. Refer to Section 23 00 00 for complete names of references identified in this section.

ASTM E84	Standard test for surface burning characteristics of building materials.
NFPA 221	Fire walls and fire barrier walls.
NFPA 255	Surface burning characteristics of building materials.
NFPA 96	Ventilation control and fire protection of commercial cooking operations.
UL 723	Test for surface burning characteristics of building materials.
UL 1978	First Edition Standard for Grease Ducts
ASTM C553	Standard specification for mineral fiber blanket thermal insulation for commercial and industrial applications.
ASTM C1071	Fibrous glass duct lining insulation (thermal and sound).
IECC	International Energy Conservation Code

ASTM C355	Water Vapor Permeance
ASTM C916-85(2001)e1	Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C1136-02	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM A635/A635M-02	Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Commercial Steel, Drawing Steel, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, Hot-Rolled, General Requirements
ASTM A924	Hot Dip Galvanized Coils & Sheets - Tolerances

1.6 QUALITY ASSURANCE

A. Fire Hazard Rating:
   1. All insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E84, NFPA 255 and UL 723. Bear UL label. All insulation must meet ASTM C553.
   2. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive.
   3. Components such as adhesives, mastics and cements must meet the same individual ratings as minimum requirements.
   4. Install in accordance with SMACNA standards.

B. Kitchen Exhaust Insulation Performance Requirements:
   1. Two-hour rated resistive enclosure assembly, ASTM E119: Large scale Wall Panel Test and Total Engulfment Test.
   2. Zero inch clearance to combustible, maximum allowable surface temperature on unexposed side, UL 1978.
   3. Class I interior finish materials, ASTM E84.
   4. Through-penetration protection systems for grease and air ducts, ASTM E814 and UL 1479.
   5. Non-combustibility, ASTM E136.
   6. ISO-6944-1985, Fire Resistance Tests - Ventilation Ducts.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original sealed containers or unopened packages, and clearly labeled with manufacturer's name, product identification, and lot numbers.

B. Store materials out of weather and in an enclosed shelter.

PART 2 PRODUCTS

2.1 APPLICATIONS

A. Supply ducts

B. Return ducts

C. Outside air ducts

D. Supply and return diffusers

E. Grilles

F. Registers with exposed surfaces in unconditioned areas

G. Kitchen exhaust ducts

H. General exhaust ducts do not receive insulation

2.2 MANUFACTURERS

A. Owens Corning

B. Knauf

C. Johns Manville

2.3 EXTERNAL DUCT WRAP AND GRILLE INSULATION

A. Minimum Density:
   1. 3/4 pound per cubic foot

B. Material:
   1. Fiberglass blanket with type FRK foil reinforced Kraft vapor barrier jacket

C. Thickness:
   1. 2.0 inch, Minimum Value R-6.0

D. Comply with ASTM C553 standard

E. Comply with ASTM C1136-02

F. Comply with ASTM E84

G. Comply with IECC

2.4 INTERNAL DUCT LINER

A. Use only where specifically noted, or with written approval of Engineer.

B. Install internal duct liner that extends no more than 2’-0” below roof deck at each rooftop unit.

C. Thickness:
   1. 1½ inch thick, Minimum Value R-6.0

D. Fasteners:
   1. Pronged straps.

E. Comply With ASTM C916-85(2001)e1

F. Comply with ASTM C1071 standard

G. Comply with ASTM C553 standard

H. Comply with ASTM C1136-02

I. Comply with ASTM E84

J. Comply with IECC

2.5 EXTERIOR DUCTWORK

A. All exterior ductwork to have R-8 insulation, weatherproof and sealed with sheet metal cover. A plastic cover is also acceptable. Insulation cover shall be pitched in order to shed water. Level or flat covers will not be approved.

B. Thickness:
   1. 3-inch with an R-value of R-8.

C. Comply with ASTM A653 & ASTM A924.

2.6 FIREPROOFING KITCHEN HOOD EXHAUST DUCTS

A. Manufacturers:
   1. Thermal Ceramics - Firemaster Duct Wrap
   2. 3M Fire Barrier Duct Wrap
   3. John Manville Firetemp Wrap

B. Materials:
   1. Fire Resistive duct wrap: Duct Wrap, 1.5" thick or 2” thick, 24" or 48" wide x 300" long rolls, foil encapsulated with logo identification. Duct Wrap Collar, 8" wide for air duct butt alternate wrap method (see Part 3).
   2. Tapes:
      a. High performance filament: Tape No. 898, 1" wide, manufactured by 3M Company, St. Paul, MN, or equal and approved.
      b. Aluminum foil tape: Minimum 3" wide to seal cut blanket edges.
   3. Banding Material:
      a. 304 Stainless Steel banding: 3/4" wide x 0.015" thick minimum.
   4. Insulation Pins/Washers:
      a. Pins: 10 gage, 5 inches long, copper coated steel; washers: 1.5" x 1.5" square or 1.5” diameter galvanized steel speed clip.
   5. Through-Penetration Fire Stop Materials:
      a. Packing Material: Scrap pieces, Duct wrap, 1.5" thick or 3 pcf mineral wool as packing material.
      b. 3M FB-2000+Silicone or FireMaster Putty, ceramic fiber based sealant.
   6. Grease Duct Access Door:
      a. Steel angle opening frame
      b. Access over, minimum 16 gage
      c. Insulation Pins
      d. Speed Clips, minimum 1.5" x 1.5" or 1.5" diameter galvanized steel
   7. Hardware:
      a. Threaded rods: 4" to 5" long, 1/4" diameter galvanized steel with 1/4" wing nuts and 1/4" metal washers.
      b. Four inch long steel hollow tubing to fit threaded rods.
      c. 1/4" wing nuts.

2.7 FIREPROOFING HAZARDOUS EXHAUST DUCTS (SCIENCE FUME HOODS)

A. Hazardous exhaust ductwork shall only be wrapped with fireproof insulation if the hazardous exhaust ductwork must pass through a fire rated wall.

B. Manufacturers:
   1. Thermal Ceramics - Firemaster Duct Wrap
   2. 3M Fire Barrier Duct Wrap
   3. John Manville Firetemp Wrap

C. Materials:
   1. Fire Resistive duct wrap: Duct Wrap, 1.5" thick or 2” thick, 24" or 48" wide x 300" long rolls, foil encapsulated with logo identification. Duct Wrap Collar, 8" wide for air duct butt alternate wrap method (see Part 3).
   2. Tapes:
      a. High performance filament: Tape No. 898, 1" wide, manufactured by 3M Company, St. Paul, MN, or equal and approved.
      b. Aluminum foil tape: Minimum 3" wide to seal cut blanket edges.
   3. Banding Material:
      a. 304 Stainless Steel banding: 3/4" wide x 0.015" thick minimum.
   4. Insulation Pins/Washers:
      a. Pins: 10 gage, 5 inches long, copper coated steel; washers: 1.5" x 1.5" square or 1.5” diameter galvanized steel speed clip.
   5. Through-Penetration Fire Stop Materials:
      a. Packing Material: Scrap pieces, Duct wrap, 1.5" thick or 3 pcf mineral wool as packing material.
      b. 3M FB-2000+Silicone or FireMaster Putty, ceramic fiber based sealant.
   6. Hardware:
      a. Threaded rods: 4" to 5" long, 1/4" diameter galvanized steel with 1/4" wing nuts and 1/4" metal washers.
      b. Four inch long steel hollow tubing to fit threaded rods.
      c. 1/4" wing nuts.

PART 3 EXECUTION

3.1 DUCT WRAP INSTALLATION

A. Wrap insulation tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 3 inches.

B. Adhere insulation to metal with 4 inch strips of insulation bonding, using adhesive at 8 inch centers.

C. On circumferential joints, secure the 2-inch flange of the facing and tape with a minimum of 3 inch wide foil reinforced Kraft tape.

D. On longitudinal joints, secure the overlap using 9/16 inch flared door staples applied 6 inches on centers and taped with minimum 3 inch wide foil reinforced Kraft tape.

E. Tape all pin penetrations or punctures in facing.

F. The duct wrap insulation on all rectangular/square ducts 24-inch or wider shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers. Spacing at 18-inch on center each direction to prevent sagging.

G. Fasten insulation installed on diffusers, grilles, and registers using 3-inch minimum wide foil reinforced Kraft tape.

H. Extend insulation 1 inch beyond each outer surface of diffuser, grille, and register.

3.2 INTERNAL DUCT LINER

A. Provide internal duct liner as indicated on the plans.

B. Install internal duct liner on rooftop unit supply and return ducts no more than 2'-0" below roof deck.

C. Apply the liner to the inside of the duct with heavy density side to the air stream and secure to the duct with adhesive Insul-Coustic No. 225 completely coating the clean sheet metal.

D. Do not use duct liner in kitchen or other areas that may have excess moisture present.

E. Secure fasteners to the ducts with adhesive.

F. Conform to SMACNA Standards for all duct construction standards.

G. Accurately cut the liner and thoroughly coat the ends with adhesive to make a firmly butted and tightly sealed joint.

H. Where ducts are lined, exterior insulation will not be needed except as otherwise specified.

I. Install duct liner in accordance with SMACNA standards.

3.3 EXTERIOR DUCTWORK

A. All exterior ductwork shall have a minimum of R-8 insulation, weatherproofed, and sealed. All exterior ductwork shall have a sloped sheet metal or plastic cover to shed water.

3.4 KITCHEN HOOD EXHAUST DUCTS

A. Install Duct wrap system in accordance with manufacturer's instructions and referenced standards.

B. Install Duct wrap in direct contact with the duct it enclosed. Protect every portion of duct with manufacturer specified layers for grease duct applications. Overlap both perimeter and longitudinal joints minimum 3" per layer of material.

C. Air Duct Enclosure Alternate Wrap:
   1. Follow same traditional wrap method with exception of utilizing a 3" perimeter overlap in conjunction with longitudinal butt joint wrap plus Duct wrap Collar over exterior layer joints. Filament tape is used as temporary hold on both layers until banding hardware is in place. Band exterior layer spaced minimum 10½" on center. For duct widths greater than 24", weld insulation pins to bottom horizontal and outer vertical duct runs. Impale Duct wrap over pins and secure with galvanized steel speed clips until banding is applied.

D. Locate grease duct access doors at horizontal cleanouts as required by local codes. Protect with minimum of 2 layers of Duct wrap, each layer overlapping previous by 1" on all sides and in accordance with manufacturer's instructions.

E. Sections of grease ducts that are inaccessible from the hood or discharge openings shall be provided with cleanout openings spaced not more than 20 feet apart and not more than 10 feet from changes in direction greater than 45 degrees.

F. Cleanouts and openings shall be equipped with tight-fitting doors constructed of steel having a thickness not less than that required for the duct.

G. Cleanout doors shall be installed liquid tight.

H. Door assemblies including any frames and gaskets shall be approved for the application and shall not have fasteners that penetrate the duct.

I. Gasket and sealing materials shall be rated for not less than 1500ºF (816ºC).

J. Protect floor and wall penetrations with an approved through-penetration system having an F and T hourly rating not less than that of assembly penetrated and installed in accordance with manufacturer's instructions and as follows:
   1. Grease Ducts - 2 hour Enclosure: Alternate A: 2 layers Duct wrap per manufacturer's installation instructions, maintaining 3" transverse and longitudinal overlaps continuous through the penetration. Alternate B: Tightly butt Duct wrap to the floor or wall on both sides of the assembly. Fill remaining annular space (3" maximum) between the wrapped duct (Alternate A) or bare steel duct (Alternate B) and periphery of the opening with 4¼" thickness of scrap Duct wrap, or 4¼" 3 pcf mineral wool batt, firmly packed into opening. Apply 1/4" minimum 2000+ Silicone over packing material, within the annulus, flush with top surface of floor or both surfaces of wall.

3.5 HAZARDOUS EXHAUST DUCTWORK

A. All hazardous exhaust ductwork that penetrates a fire rated wall shall be wrapped with fireproof insulation for a minimum of 10’-0” from the point of penetration.

END OF SECTION

SECTION 23 07 19

HYDRONIC PIPING INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Hydronic Piping Insulation
   1. The work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to the following piping systems:
      a. Chilled water systems from 35°F (2°C) to 65°F (18°C) valves and appurtenances.
      b. Space heating systems (hot water), ambient up to 250°F (121°C) valves and appurtenances.
      c. 1” Elastomeric closed-cell structure insulation (Armaflex). For ease of installation, closed cell structure insulation to be installed within 36” of coil connections, valve connections, and pump connections.

1.3 RELATED SECTIONS

A. Section 22 07 20 - Piping Insulation

B. Section 23 00 00 - Basic Mechanical Requirements

C. Section 23 07 21 - Refrigerant Piping Insulation

D. Section 23 21 13 - Hydronic Piping, Valves, and Appurtenances

1.4 REFERENCES

A. Refer to Section 23 00 00 for complete names of references identified in this section.

ASTM E 84	Fire and Smoke Ratings
ASTM C 177	Standard Test Method for Steady-State Heat Flux Measurements & Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C 547	Specification for Mineral Fiber Pipe
ASTM C 585	Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)
ASTM C 795	Standard Specifications for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C 1136	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
NFPA 255	Surface Burning Characteristics of Building Materials
UL 723	Composite Surface Burning Characteristics
MICA	Midwest Insulation Contractors Association - National Commercial & Industrial Insulation Standards

1.5 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 1.

B. Submit product data indicating typical catalog of information.

C. Submit product data sheets indicating dimensions, general assembly, and ratings.

D. Submit manufacturer's installation instructions and method of application.

E. Submit piping insulation summary sheet, which includes at least the following: type of pipe and pipe thickness, type of insulation and insulation thickness, and jacketing material.

1.6 DEFINITIONS

A. Concealed: Hidden from sight as in trenches, chases, furred spaces, walls, pipe shafts, or hung ceilings.

B. Exposed: Not "concealed" as defined above. Normally open and visible to building occupants (such as gymnasiums, mechanical rooms etc.).

C. Crawlspace: Under the building slab in an unconditioned space that is exposed to ambient conditions.

1.7 QUALITY ASSURANCE

A. Fire Hazard Rating:
   1. All insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E84, NFPA 255 and UL 723. Bear UL label. All insulation must meet ASTM C553.
   2. These ratings must be tested on the composite of insulation, jacket or facing, and adhesive.
   3. Components such as adhesives, mastics and cements must meet the same individual ratings as minimum requirements.

B. Quality Controls:
   1. All insulation shall be the product of reputable manufacturers.
   2. All insulation shall be applied by licensed mechanics skilled in the use of various insulations, adhesives, and jacketing materials. Submit qualifications of insulator with insulation submittals.
   3. The materials shall be applied in accordance with the special materials as required by these specifications and by the manufacturer standards.
   4. Poor workmanship or appearance will be cause for rejection.
   5. Insulation materials that have become wet or contaminated shall not be installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Unifrax

B. Owens/Corning

C. Armstrong

D. Knauf

E. Johns Manville

F. PolyGuard

2.2 GENERAL

A. Molded pipe insulation shall be manufactured to meet ASTM C 585 for sizes required in the particular system. It shall be of a type suitable for installation on piping systems as defined in section above.

B. Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547.

C. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of applicable building codes when tested in composite form per one of the following nominally equivalent test methods:
   1. American Society for Testing of Materials - ASTM E 84
   2. Underwriters' Laboratories, Inc. - UL 723
   3. National Fire Protection - NFPA 255

2.3 ABOVE GROUND PIPE INSULATION

A. Thermal Conductivity (K) value:
   1. Chilled water piping systems: 0.21 - 0.27 BTU•in/(hr•ft•°F) at 75°F mean temperature.
   2. Hot water piping systems: 0.25 - 0.29 BTU•in/(hr•ft•°F) at 125°F mean temperature.

B. Construction:
   1. Fiberglass pipe insulation complying with ASTM C 547
   2. Vapor retarding jacket with self-sealing longitudinal closure laps and butt strips complying with ASTM C 1136.

C. Minimum Pipe Insulation Thickness:
   1. Chilled water piping systems (Fiberglass Insulation):
      a. Indoor Applications (above ceilings, mechanical rooms):
         (1) 1 1/2” Diameter piping and less - 1 1/2" insulation thickness
         (2) All piping greater than 1 1/2" Diameter - 1 1/2” insulation thickness.
      b. Outdoor Applications:
         (1) All pipe sizes - 2" insulation thickness
      c. Crawlspace Applications:
         (1) All pipe sizes - 2” insulation thickness
   2. Hot water piping systems:
      a. Indoor Applications (above ceilings, mechanical rooms):
         (1) 1 1/2” Diameter piping and less - 1 1/2" insulation thickness
         (2) All piping greater than 1 1/2" Diameter - 2” insulation thickness.
      b. Outdoor Applications:
         (1) All pipe sizes - 2" insulation thickness
      c. Crawlspace Applications:
         (1) All pipe sizes - 2” insulation thickness
   3. Condenser water piping systems:
      a. Indoor Applications (above ceilings, mechanical rooms):
         (1) Insulation is not required.
      b. Outdoor Applications:
         (1) All pipe sizes - 2" insulation thickness with electric heat trace tape.

2.4 JACKETING MATERIALS

A. Manufacturers:
   1. Venture Tape
   2. Polyguard
   3. Foster Childers
   4. Ideal Tape

B. Indoor Applications:
   1. Flexible, zero permeability, absolute vapor barrier of 5-ply cold weather acrylic adhesive construction by Venture Tape VentureWrap 1579GCW, or equal with 3-inch butt strips. Meets or exceeds ASTM C1136.

C. Outdoor Applications:
   1. Flexible, zero permeability, absolute vapor barrier of 5-ply cold weather acrylic adhesive construction by Venture Tape VentureClad 1577CW, or equal with 3-inch butt strips. Meets or exceeds ASTM C1136.
   2. Metal jacketing shall be 0.016-inch minimum aluminum or stainless steel with moisture barrier, secured in accordance with jacket manufacturer's recommendations. Use bands and seals of the same material. Use preformed fitting covers matching jacket used on straight pipe, with all joints weather sealed with metal sealant.

D. Mechanical Rooms and Exposed Indoor Applications:
   1. Flexible, zero permeability, absolute vapor barrier of 5-ply cold weather acrylic adhesive construction by Venture Tape VentureWrap 1579GCW or equal with 3-inch butt strips. Meets or exceeds ASTM C 1136.
   2. PVC jacketing secured in accordance with jacket manufacturer’s recommendations. Use preformed fitting covers matching jacket used on straight pipe with all joints sealed.

E. Crawlspace Applications:
   1. Flexible, zero permeability, absolute vapor barrier of 5-ply cold weather acrylic adhesive construction by Venture Tape VentureClad 1577CW, or equal with 3-inch butt strips. Meets or exceeds ASTM C 1136.
   2. PVC jacketing secured in accordance with jacket manufacturer’s recommendations. Use bands and seals of the same material. Use preformed fitting covers matching jacket used on straight pipe with all joints sealed.

F. Direct Buried Condenser Water Piping:
   1. Cathodic protection shall be applied to all steel condenser water piping that is directly buried below grade. Cathodic protection is a method of corrosion prevention for steel piping buried below grade.

2.5 FLANGE, VALVE AND FITTING INSULATION

A. Insulate fittings and valves with Hi-Lo temp fiberglass insulation inserts covered with molded fitting PVC jacket covers. PVC - 30 mil thickness, UV resistant and secured and sealed with tape. Equal to Zeston 2000 by Johns Manville.

B. On all chilled water lines the insulation system shall be completely vapor sealed before weather-resistant jacket is applied. Coat all flanges, valves and fittings with Foster 30-35 or Childers CP-30LO vapor barrier coating and reinforcing mesh.

C. Valves:
   1. All valves are to have insulated extension handles.

2.6 SEALANT AND COATING

A. Joint Sealant:
   1. Shall be a high solids containing non-setting butyl rubber product.

B. Manufacturers:
   1. Foster Flextra Sealant 95-50
   2. Childers Chil Byl CP-76.

C. Usage:
   1. Valve covers, anchors and hangers
      a. Longitudinal laps of the vapor barrier jacket
      b. Butt joint covers.

D. Direct Buried Condenser Water Piping:
   1. Cathodic protection shall be applied to all steel condenser water piping that is directly buried below grade. Cathodic protection is a method of corrosion prevention for steel piping buried below grade.

2.7 VAPOR BARRIER COATING

A. Manufacturers:
   1. Foster 30-35
   2. Childers CP-30LO

B. Usage:
   1. On all elbows/fittings on below ambient piping. Used in conjunction with reinforcing mesh.

2.8 METAL JACKET SEALANT

A. Manufacturers:
   1. Foster 95-44
   2. Childers CP-76

B. Usage
   1. Seal metal jacketing overlaps and at flashing penetrations.

2.9 WEATHER BARRIER MASTIC

A. Manufacturers:
   1. Foster 46-50
   2. Childers CP-10

B. Usage
   1. Used on piping to protect insulation from weather. Used in conjunction with reinforcing mesh.

2.10 PIPE SUPPORTS

A. Pipe supports to be equal to Koolphen K-Block inserts, full circumference high density ridge phenolic foam insulation that can withstand bearing load from the pipe.

2.11 INSULATION SHIELD

A. Field-fabricated:
   1. Construction:
      a. Insulation to support the bearing area at hangers and supports with a shield of galvanized metal extending not less than 4 inches on either side of the support bearing area, covering at least half of the pipe circumference. When pipe is guided at top and bottom, metal shields should cover the whole pipe circumference. Adhere metal shield to insulation so that metal will not slide with respect to insulation.

B. Schedule:
   1. 3-inch and smaller pipe diameter: 12 inch insulated section, 18 gauge metal shield
   2. Greater than 3-inch pipe diameter: 12 inch insulated section, 16 gauge metal shield

C. Factory-made:
   1. Manufacturer:
      a. Pipe Shields, Inc. or equal.
   2. Type:
      a. Proper shield for service and pipe span.
   3. Construction:
      a. Extend insulation at least 1 inch beyond metal.
      b. Insulation shall not compress at hanger.

2.12 ELASTOMERIC CLOSED-CELL STRUCTURE INSULATION

A. Equivalent to Armacell by Armaflex
   1. Closed cell elastomeric insulation complies with ASTM C 534, ASTM E 84
   2. Chilled water piping systems:
      a. Thermal Conductivity (K Value): 0.21 - 0.27 BTU*in/(hr*ft*°F) at 75°F mean temperature.
      b. 1 1/2” Diameter piping and less - 1 1/2" insulation thickness
      c. All piping greater than 1 1/2" Diameter - 1 1/2” insulation thickness
   3. Hot water piping systems:
      a. Thermal Conductivity (K Value): 0.25 - 0.29 BTU*in/(hr*ft*°F) at 125°F mean temperature.
      b. 1 1/2” Diameter piping and less - 1 1/2" insulation thickness
      c. All piping greater than 1 1/2" Diameter - 2” insulation thickness
   4. Maximum water vapor transmission of 0.08 perm-inches in accordance with ASTM E 96
   5. Adhesives:
      a. Armaflex 250 or Armaflex 520 BLV or equivalent
   6. May be installed within 3 ft of chilled water coils, hot water coils, and on pump bodies.

PART 3 EXECUTION

3.1 SITE INSPECTION

A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.

B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 PREPARATION

A. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean, dry and free from dirt, scale, moisture, oil and grease prior to installing insulation.

B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.

C. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follow:
   1. Carbon Steel: Coat carbon steel piping operating at a service temperature between 32°F and 300°F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

D. Complete pressure testing of piping and fittings prior to installing insulation.

3.3 INSTALLATION

A. Install all insulation materials and accessories in accordance with manufacturer's published instruction and recognized industry practices (MICA) to ensure that it will serve its intended purpose.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, piping, fittings, valves, specialties, etc.

C. Install insulation materials, forms, vapor barriers, jackets, etc. to the thicknesses required for each item and equipment.

D. All penetrations of the jacket and exposed ends of insulation shall be sealed with vapor barrier coating. The jacket shall be protected with the specified vapor retarding outer jacket. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion. Mark each joint so that Engineer can verify.

E. Install insulation on piping subsequent to installation of heat tracing, painting, and acceptance tests.

F. Do not install insulation on any pipe if chiller is operating.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with the least number of joins practical.

3.4 INDOOR PIPE

A. Insulation thickness shall match corresponding pipe size.

B. Insulation to be continuous through wall and ceiling penetrations.

C. Insulation to be continuous over all valves and appurtenances.

D. Insulation shall be applied to piping with all joints tightly fitted to eliminate voids. For systems operating at or below 35 degrees all joints must be sealed full depth with sealant. Do not install insulation on cold or wet pipes.

E. Sealant shall not be used to fill voids or cracks.

F. Insulation sections shall be secured with aluminum bands. Two strips of reinforced tape may be used in place of bands if exterior bands are used with jacketing. The tape shall overlap itself by 50%.

G. Apply absolute vapor barrier jacketing in accordance with manufacturer's instructions, insuring a minimum 3-inch lap at all longitudinal joints. All circumferential joints should butt as close as possible. A 3-inch wide butt strip shall be applied over the circumferential joints. All laps and butt strips shall be adhesive-faced (self-seal).

3.5 VALVES, FLANGES, AND FITTINGS

A. Insulate all valves, flanges, and fittings with covers secured with Velcro with equivalent thickness and composition installation on straight pipes.

B. Finish with 1/4 inch layer of Foster 30-35 or Childers CP-30LO reinforced with reinforced mesh.

C. Factory made covers equal to Schuller Zeston are acceptable.

3.6 CONTROL VALVE COVERS

A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.

B. Seal covers to valve insulation properly with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve.

C. Finish valve cover with glass cloth and two coats of vapor barrier coating.

D. Factory made covers are acceptable. Provide submittal.

3.7 REPAIRS AND REPLACEMENT

A. Replace any insulation that has ever been wet.

B. Repair any damage caused by condensation due to improper insulating.

3.8 INDOOR EXPOSED PIPING

A. Insulate piping exposed to view with a PVC jacket to present a smooth finished look.

B. Install PVC jacketing with 1-inch overlap at longitudinal seams and end joints.

C. PVC jacketing color to be coordinated with architect/ engineer. PVC jacketing to be colored at the factory. Do not field paint PVC jacketing.

3.9 CRAWLSPACE PIPING

A. Insulate piping with a PVC jacket to present a smooth finished look.

B. Install PVC jacketing with 1-inch overlap at longitudinal seams and end joints.

C. PVC jacketing color to be coordinated with architect/ engineer. PVC jacketing to be colored at the factory. Do not field paint PVC jacketing.

3.10 OUTDOOR PIPING

A. Aluminum jacketing shall be applied with all laps positioned to shed water. All laps shall be a minimum of 2-inch.

B. Metal jacketing shall be 0.016" minimum aluminum or stainless steel with moisture barrier, secured in accordance with jacket manufacturer's recommendations.

C. Aluminum jacketing shall be secured using bands and seals as specified. Band spacing shall be two bands equally spaced per section of insulation. This will usually mean 9-inch or 12-inch on center. Seal all jacketing overlaps with metal jacketing sealant with 1/8” bead under each lap.

D. Do not field paint aluminum jacketing.

3.11 SHIELDS AND HANGERS

A. Where piping hangers or anchors must be in direct contact with pipe, seal off the pipe insulation on both sides of the hanger by carrying the vapor seal down to the bare pipe.

B. At the location of hangers or supports for pipes run above ground and finished with a vapor seal insulation, provide rigid sections of insulation the same thickness as adjacent insulating material to adequately support the pipe without compression of the insulating material and cover with a vapor seal that is bonded to the adjacent insulation as described for fittings in the lines. Wood inserts shall not be allowed. Hangers and supports for piping insulation to receive a vapor barrier shall be installed exterior to the insulation.

C. Material Changes:
   1. Wherever there is a change in materials on lines that are vapor sealed, apply a suitable adhesive that is compatible with both materials, tapes, etc., as required to maintain the vapor barrier.

D. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe.

E. Take care to avoid puncturing the vapor seal.

F. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.12 FIELD QUALITY ASSURANCE

A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.13 PROTECTION

A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

END OF SECTION

SECTION 23 07 21

REFRIGERANT PIPING INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Elastomeric closed-cell structure insulation

B. Applications - Refrigerant suction lines serving cooling units

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 07 19 - Hydronic Piping Insulation

C. Section 23 23 00 - Refrigerant Piping

1.4 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 1.
   2. Submit product data indicating typical catalog of information.
   3. Submit product data sheets indicating dimensions, general assembly, and ratings.
   4. Submit manufacturer's installation instructions.

1.5 SHOP DRAWINGS

A. Submit 1/4" per foot shop drawing(s) showing all piping and equipment shown by plans and specifications. The drawings shall be coordinated with structural, electrical, and fire sprinkler drawings.

1.6 REFERENCES

A. Refer to Section 23 00 00 for complete names of references identified in this section.

B. ASTM E 84-03 - Standard Test Method for Surface Burning Characteristics of Building Materials

C. ASTM C 355 - Water Vapor Permeability

1.7 QUALITY ASSURANCE

A. Fire Endurance Rating: The composite classifications shall not exceed the flame spread rating and the smoke development rating as outlined by NFPA 255/ ASTM E-84 for the basic material, the finishes, adhesives, etc., specified for each system, and shall be such when completely assembled.

B. Components such as adhesives, mastics and cement must meet the same requirement.

PART 2 PRODUCTS

2.1 PIPE INSULATION

A. Type: Closed-cell polyethylene pipe insulation.

B. Performance Criteria: Resistant to ultra-violet and biological degradation.

C. Temperature Range: -90°F to 200°F

D. Water Vapor Permeability (Dry Cup): Less than 0.03 per inch when measured by ASTM C355.

E. Thermal Conductivity: 0.25 - 0.29 BTU-IN/HR-FT^2-°F.

F. Refrigerant Suction Lines Insulation thickness - 1½-inches

G. Manufacturer/Model:
1. Armacell
2. Aeroflex

2.2 SEALANT & ADHESIVE

A. Manufacturer/Model:
1. Therma-Cel
2. Armstrong
3. Aeroflex

2.3 FINISHES

A. Manufacturers:
1. WB Armstrong Finish - White
2. Aeroflex
3. VentureClad

PART 3 EXECUTION

3.1 PIPE

A. Where straps or hangers are used, provide insulation shield.

B. Apply insulation to clean, dry pipes.

C. Butt insulation joints firmly together.

D. Seal butt seams with sealant. Duct tape or electrical tape will not be permitted.

E. Install in accordance with manufacturer's instructions.

F. Accomplish in a good workmanship manner and be neat in appearance.

G. Insulation not neat in appearance will be rejected by the Engineer.

H. Do not stretch insulation around elbows.

I. Install insulation on piping prior to final connection.

J. Longitudinal joints installed after pipe is assembled are not acceptable.

K. Refer to plans for installation of shields around pipe hangers.

L. Do not allow liquid lines to come in contact with any structural members or steel stubs. Use plastic ties to secure liquid lines to insulation on vapor line. Do not crush insulation.

3.2 FINISH

A. All insulation to be painted with WB Armstrong Finish, or equivalent. Apply as recommended by the manufacturer, to protect the insulation on exterior of building. Apply above 50°F. Apply to dry insulation only.

3.3 VALVES, FLANGES & FITTINGS

A. Insulate all valves, flanges, and fittings in a neat manner.

3.4 REPAIRS & REPLACEMENT

A. Replace any insulation that has ever been wet.

B. Repair any damage caused by condensation due to improper insulating.

C. Replace any insulation which is cut or torn during construction.

END OF SECTION

SECTION 23 09 23

ENERGY MANAGEMENT CONTROL SYSTEM (BACNET/TRIDIUM)

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SUMMARY

A. It is the intent of this specification to describe the basic architecture and performance requirements of the Energy Management Control System (EMCS). The turn-key EMCS shall include all software including operator software, programming tools, graphics editor, all other available software programs, modules, or plug-ins offered by the DDC manufacturers, hardware, Control Units, Distributed Controllers, Unitary Controllers, Local Area Networks (LANs), sensors, modems, wiring, connectors, control devices, actuators, installation and calibration, supervision, adjustments and fine tuning necessary for a complete and fully operational system.

B. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2001, BACnet. This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc. and all air handlers, boilers, chillers, and any other listed equipment using Native BACnet-compliant components.

C. All systems shall be complete true stand-alone systems.

D. LonWorks or proprietary protocol software is not allowed.

E. Everything shall be reprogrammed through software without change of any hardware. The owner shall have all the tools necessary to reprogram without any additional costs.

F. EMCS shall have backward and forward compatibility.

G. Systems shall be furnished and installed complete in all respects, including any and all equipment, controls, wiring, instrumentation, enclosures, labor, engineering, training, commissioning, programming, supervision, calibration, coordination with other trades, etc. No information given in (or omitted from) these specifications shall relieve the contractor of this absolute requirement. Include all associated electrical work except as noted. Work includes furnishing of all labor, superintendence, materials, tools, equipment and sources necessary for the complete installation or modification of the following systems as herein specified. It is the intent of these specifications that the Contractor shall furnish and install the systems complete in every respect and ready to operate. All equipment, miscellaneous items and accessories required for such installation and for the correct and convenient operation of the entire installation whether or not each such item or accessory is shown on the plans or mentioned in these specifications shall be furnished and installed.

H. Should discrepancies or ambiguities arise within these specifications, the most stringent condition with regard to cost shall govern the bid. Obtain clarification from the Engineer prior to purchasing equipment and proceeding with the work.

I. Where drawings are provided as part of or supplement to these specifications, such drawings are inherently schematic only and not intended to convey all controls, wiring, installation, details, etc. It shall be the responsibility of the EMCS contractor to verify that control approaches presented are appropriate for the HVAC systems involved, and that bids include all work described, specified, or otherwise necessary for a complete and functioning system.

J. Schedule: Contractor acknowledges that submission of bid constitutes agreement with and conformance to the completion dates.

K. Codes, Permits, and Fees: This contractor shall comply with all local, state and national codes, and shall secure and pay or all applicable costs, fees, permits, and licenses. No additional costs shall be allowed for these items.

L. Other Conditions:
1. Safety: Execute all work with the highest regard to safety. Comply with all laws governing safety, including the "Occupational Safety and Health Standards" and the "Safety and Health Regulations for Construction", State and federal. All applicable power tools used during construction shall have current approval under an approved Equipment Grounding Program, and shall bear the tag relating such. Contractor is solely responsible for all means and methods.
2. Coordination and Supervision: Each bid shall include the necessary detail and interconnection work to coordinate his work with the work of other trades. Contractor shall keep competent supervisory personnel on the job whenever work is being performed which affects his trade.
3. Storage of Materials: Each Contractor shall provide temporary storage facilities suitable for equipment stored at the job site. Storage facilities shall be weatherproof and lockable as required.
4. Protection of Building and Materials: Each Contractor shall take necessary precautions to prevent damage to existing buildings and to work of other trades.
5. Observations: Site observation by Owner or Engineer is for express purpose of verifying compliance by Contractor with Contract Documents, and shall not be construed as construction supervision nor indication of approval of manner or location in which work is being performed as being safe practice or place.
6. Contractor is reminded that he shall also comply with all respects to the Invitation to Bid, General Conditions, Supplementary Conditions, Notice of Bidders, Instructions to Bidders, and all other governing parts of these specifications and the contract documents. These sections are included as part of the contract.
7. Where the term "Contractor" is used within these specifications, it shall be understood to mean an approved controls manufacturer/contractor, and facility management systems contractor.

M. The entire system shall be approved and listed by Underwriters Laboratories, Inc., under UL916 for energy management systems and FCC-Part 15 Subparagraph J Class A Emissions Requirements.

N. Equipment and Software Updates/Upgrades:
1. Equipment: All equipment, components, parts, materials, etc. provided throughout the period of Work (as governed in the Agreement) shall be fully compatible with all other equipment, etc. provided at any other time throughout the period of Work. Should updated versions of equipment be provided which are not fully compatible with earlier equipment provided, Contractor shall replace earlier equipment with the later version at no cost to Owner.

2. Software: All software upgrades applicable to system and offered by the manufacturer/contractor for this system shall be provided at no cost to the Owner throughout the period of work. This no cost upgrade shall include installation, programming, modifications to field equipment, data base revisions, training, etc. as appropriate.

O. The Engineer shall reserve all authority regarding approval, conditional approval, or rejection of systems not fully complying with these specifications.

1.3 WORK INCLUDED

A. The EMCS shall be a totally Native BACnet-based system, based on a distributed control system in accordance with this specification. All building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2001, BACnet. In other words, all controllers, including unitary controllers, shall be Native BACnet devices. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to existing systems or to systems installed under other sections.

B. The owner will provide reserved DHCP addresses and any other network configuration information necessary to each control contractor for the purpose of configuring each JACE on the owner network. The controls contractor shall coordinate the IP addressed for each JACE. It shall be the responsibility of each control contractor to coordinate with the owner for network connectivity.

C. The controls contactors shall supply, install, configure and program at least one JACE for each building. It shall be the control contractor's responsibility to determine how many JACE controllers will be required to limit congestion and to maintain system reliability and stability. The JACE or JACEs will be the primary operator interface for the building. All JACEs must be supplied with open licenses and be configured to work with any other Niagara JACE or N4 Supervisor. Configure each JACE with all User Interface, Connectivity, and Embedded Workbench tools and licenses to allow for standalone operation as well as integration into a future enterprise system. All JACEs shall also be supplied with battery backup or with SRAM Data Recovery Service with provisions for automatic restart and database backup in case of power failure. Additionally, all drivers necessary and required to function with the installed control components within the scope of work for each building shall be the responsibility of the control contractor.

D. The Energy Management Control System (EMCS) application program shall be written to communicate specifically utilizing BACnet protocols. Software shall include password protection, alarming, logging of historical data, full graphics including animation, full suite of field engineering tools including graphical programming and applications. Systems using operating systems other than that described above are strictly prohibited.

E. All application controllers for every terminal unit (VAV, HP, UV, etc.) air handler, all central plant equipment, and any other piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller via BACnet LAN.

F. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

G. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

H. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

I. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

J. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

K. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

L. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

M. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

N. Provide a comprehensive operator and technician training program as described herein.

O. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

P. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

Q. Unless otherwise specified, all products shall be of single manufacturer where possible with substitutions approved by Engineer/Owner.

R. Provide all indicating devices, interface equipment, and other apparatus required to operate mechanical system and to perform functions specified and to operate other items specified.

S. Provide protective devices to prevent damage to the EMCS as a result of lightning.

T. The Energy Management Control system shall allow full user operation with minimum of training. It shall have an English language display, with both user prompts and a "help" user tutorial. It shall contain management reports for the monitoring of both current and historical energy usage, heating and cooling degree day, building status and after hours occupancy information.

U. All applications programs shall be pre-engineered and pretested. Program entries shall utilize graphical templates.

V. Workmanship:
   1. Contractor shall use only thoroughly trained and experienced workmen completely familiar with the items required and with the manufacturers recommended methods of installation. In all respects, the workmanship shall be of the highest grade, and all construction shall be done according to the best practice of the trade. Unless otherwise noted, conduit shall be concealed and installed square to the building lines. Any work not meeting these requirements shall be replaced or rebuilt without extra expense to the Owner.
   2. Bidder shall perform sufficient site investigations to include all requirements described in the construction documents. Bids shall include, at Bidder's discretion, costs related to site verifications for renovation projects. No additional costs shall be allowed for such items.

1.4 RELATED SECTION

A. Section 23 00 00 - Basic Mechanical Requirements

1.5 DEFINITIONS

A. Energy Management Control System, Facility Management System, Control System are to be considered the same.

1.6 N4 SUPERVISOR STRUCTURE

A. The Controls Contractor shall NOT be required to provide a Campus Wide N4 Supervisor as part of this contract. The N4 Supervisor shall be utilized for aggregation of the campuses within this contract and in the future for further campuses.

B. The future Campus Wide N4 Supervisor shall be responsible for the following services:
   1. Campus Wide Login information such as Users, Navigation
   2. Graphics Files necessary for central login and navigation
   3. Graphics files necessary for aggregation of information from the district wide system.
   4. Critical alarm console for display of critical alarms from the district wide system.
   5. Uploaded histories, data storage and retrieval
   6. Automatic back-up of each Site N4 Supervisor or JACE.

C. For campuses where multiple JACE controllers are needed, a Site N4 Supervisor or a JACE configured as a Supervisor for the subordinate JACE controllers shall be provided at each campus.

D. The Site N4 Supervisor shall be responsible for the following services:
   1. Site Login information such as Users, Navigation
   2. Campus-specific graphics files and user interface graphics.
   3. Local alarm console for display of campus specific alarms.
   4. Uploaded histories, data storage and retrieval of campus specific trends.
   5. Email service for alarm notification of critical alarms.
   6. Automatic back-up of each JACE at the campus.
   7. Scheduling of equipment at the campus.

E. For campuses where multiple JACE controllers are needed, the JACEs shall be responsible for the following services:
   1. Generation of alarms
   2. Generation of data history on monitored points.
   3. All DDC logic. Field controllers would still contain their associated logic.

F. For campuses where a single JACE controller is needed, the JACE shall be responsible for the following services:
   1. Site Login information such as Users, Navigation
   2. Campus-specific graphics files and user interface graphics.
   3. Local alarm console for display of campus specific alarms.
   4. Uploaded histories, data storage and retrieval of campus specific trends.
   5. Email service for alarm notification of critical alarms.
   6. Scheduling of equipment at the campus.

1.7 REFERENCES

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof , shall govern design and selection of equipment and material supplied:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
2. ANSI/ASHRAE Standard 135-2001, BACnet.
3. Uniform Building Code (UBC), including local amendments.
4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
5. National Electrical Code (NEC).
6. FCC Part 15, Subpart J, Class A.
7. EMC Directive 89/336/EEC (European CE Mark).
8. City, county, state, and federal regulations and codes in effect as of contract date.
9. Except as otherwise indicated the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

1.8 SPECIFICATION NOMENCLATURE

EMCS	Energy Management and Control System
WAN	Wide Area Network
RWS	Remote Work Station
HHI	Hand Held Interface
LAN	Local Area Network

1.9 QUALITY ASSURANCE

A. Responsibility:
   1. The supplier of the EMCS shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished.

B. Component Testing:
   1. Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. Each and every controller, sensor, and all other DDC components shall be individually tested by the manufacturer prior to shipment.

C. Tools, Testing and Calibration Equipment:
   1. The EMCS supplier shall provide all tools, testing, and calibration equipment necessary to ensure reliability and accuracy of the system.

1.10 SUBMITTALS

A. Drawings
   1. The system supplier shall submit detailed complete, engineered drawings, control sequence, and bill of materials for approval.
   2. Drawings shall be submitted in the following standard sizes: 11” x 17” (ANSI B).
   3. Eight complete sets (copies) of submittal drawings shall be provided.
   4. Drawings shall be available on CD or flash drive.

B. System Documentation
   1. Include the following in submittal package:
      a. Data sheets for all pieces of equipment.
      b. System configuration diagrams in simplified block format.
      c. All input/output object listings and an alarm point summary listing.
      d. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
      e. Complete bill of materials, valve schedule and damper schedule.
      f. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.

g. Overall system operation and maintenance instructions including preventive maintenance and troubleshooting instructions.

C. For all system elements - operator's workstation(s), building controller(s), application controllers, routers, and repeaters, provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2001.

D. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.

E. A list of all functions available and a sample of function block programming that shall be part of delivered system.
   1. Scheduling
      a. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents and shall indicate timing and dates for system installation, debugging, and commissioning.
   2. Drawings and Manuals:
      a. Upon completion of the work, the Contractor shall provide the Owner with "record" layouts for the system. Layouts shall indicate all equipment and the function of each item shall be indicated.
   3. Operating instructions and as-built system flow diagrams and drawings shall be prepared, bound and delivered to the Owner. Each sensor, relay, switch, motor, controller, indicator (when inside panel), and item of equipment, etc., shall be identified with a number or mark identical to one which shall be tagged on each item. Large items of equipment may be identified by a suitable symbol listed in a legend on the control diagram.

1.11 EMCS CONTRACTOR QUALIFICATION REQUIREMENTS

A. The Energy Management Control System Manufacturer/Contractor, to be acceptable to this project, must have had an established engineering and service office serving the Owner's area for a minimum of five years prior to bid date of this project and be the authorized installing contractor for the manufacturer of the BACnet components. This office shall have a staff of factory trained technicians fully capable of rendering training, instruction, calibration procedures and routine and emergency maintenance service on all system components furnished.

B. Installers shall have not less than five years' experience with electronic and pneumatic controls.

C. The entire system shall be provided by a qualified and approved Controls Manufacturer/Contractor. It shall be designed by engineers and installed by competent technicians, all of which are regularly employed by the manufacturer of the control equipment. The Manufacturer/Contractor shall maintain permanent local facilities for engineering, installation, and 24 hour maintenance and service. Submit required Qualifications Form as specified. The manufacturer shall provide evidence of the ability to support and service the work in the Owner's facilities.

D. The Bidder/Contractor shall be certified by the manufacturer of the equipment and have factory trained installers

E. Equipment and performance are intended as a standard of quality, but not as a means of excluding other approved Manufacturers/Control Contractors.

1.12 GRAPHICS

A. All graphical interfaces shall use standard Tridium devices that are available with the JACE. No proprietary graphics shall be utilized on these projects.

B. The graphics provided shall be part of the Control Contractor's proposal. The purchase of additional licenses or graphics shall not be required for a complete and working graphical interface including dashboard or control panels, trends, alarms, etc.

1.13 WARRANTY

A. The temperature control contractor shall guarantee all workmanship and material in the installed temperature regulation system for a period of one (1) year, such guarantee dating from the date of final acceptance of the entire air conditioning system by the Architect/Engineer.

B. This warranty shall cover the repair or replacement without additional costs to the Owner of any defective materials, parts, etc. of facility workmanship.

C. During the warranty period, the temperature controls contractor shall respond to calls for warranty service within eight (8) working hours. Emergency service shall be obtainable within four (4) hours of notification by the Owner. Emergency service shall be obtainable on a 24 hour basis, seven (7) days per week.

D. The temperature control contractor's office shall be within a 150-mile radius of the job site.

E. Warranty Access:
1. The Owner shall grant to the Contractor, reasonable access to the EMCS system during the warranty period. The owner shall provide, at no cost to the contractor, remote software access to an on-site computer or VPN access for the following functions:
   a. Access to the entire facility control system by the contractor to provide service and diagnostic support.

F. Service:
1. All service of the system shall be furnished by the Contractor, at no cost to the Owner, for a period of one (1) year, concurrent with the warranty period specified above.

PART 2 PRODUCTS

2.1 ACCEPTABLE EMCS VENDORS

A. Texas Building Controls

B. The Engineer and Owner shall reserve all authority regarding approval, conditional approval, or rejection of systems not fully complying with these specifications

2.2 MATERIALS

A. General: All materials and equipment used shall be standard components, of regular manufacture for this application. All systems and components shall have been thoroughly tested and proven in actual use.

B. Exceptions to the specification will qualify bid as unacceptable.

2.3 OPERATOR'S WORKSTATION

A. **This system is an addition to the existing control system and shall be connected to the existing local area network (LAN) and computer. No additional work station is required.**

B. **The new graphics software shall be fully integrated to the owners existing front end software and existing workstation. Floor plan and interactive color graphics shall be provided for the school with each zone providing color indication of the zone comfort level. In addition to the floor plan graphic, each piece of controlled equipment shall be represented by a graphic that is accessible by clicking on the zone or indicated piece of equipment. All points shall be available on the graphic.**

C. Software:
   1. EMS software shall be provided as an all-inclusive package. Software package shall allow the owner to have all the software modules/software tools that the controls contractor has for installation. The district shall have the software tools to be 100% self-sufficient when it comes to programming the systems, modifying DDC and graphics, creating reports and trends, etc. Provisions to provide software at each school campus at no additional charge in the future must be included as a part of this bid.

D. Software shall include the following, but not be limited to:
   1. DDC Programming tool
   2. All points binding and interoperability software to make the system truly open
   3. Graphic editing tools
   4. Energy management tools
   5. Trending tools

E. Graphics:
   1. Graphics pages shall consist of the following graphics at a minimum:
   2. District Map
   3. Floor plans (typical of every school for both space temperature and humidity)
   4. Animated Unit Summary Pages (one per piece of HVAC equipment)
   5. Text Summary Pages (one per piece HVAC equipment)
   6. Time Schedule Pages
   7. Run times Page
   8. Graphics Editing Mode
   9. Trendlog Page

F. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 clients simultaneously. Provide software licenses for server and 20 clients.

G. Displays:
   1. Operator's workstation shall display all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's workstation shall display all data using three-dimensional graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. Workstation shall allow user to change all field-resident EMCS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no

matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

2. All displays and programming shall be generated and customized by the local EMCS supplier and installer. Systems requiring factory programming for graphics or DDC logic are specifically prohibited.
3. Binary objects shall be displayed as ACTIVE/INACTIVE/NULL or with customized text. Text shall be justified left, right or center as selected by the user. Also, allow binary objects to be displayed as individual change-of-state graphic objects on the display screen such that they overlay the system graphic. Each binary object displayed in this manner shall be assigned up to three graphic files for display when the point is ON, OFF or in alarm. For binary outputs, toggle the object's commanded status when the graphic item is selected with the system mouse. Similarly, allow the workstation operator to toggle the binary object's status by selecting with the mouse a graphic of a switch or light, for example, which then displays a different graphic (such as an "ON" switch or lighted lamp). Additionally, allow binary objects to be displayed as an animated graphic. Animated graphic objects shall be displayed as a sequence of multiple graphics to simulate motion. For example, when a pump is in the OFF condition, display a stationary graphic of the pump. When the operator selects the pump graphic with the mouse, the represented object's status is toggled and the graphic of the pump's impeller rotates in a time-based animation. The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF. Allow operator to change graphic file assignment and also create new and original graphics online. System shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.
4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic. Each analog input object may be assigned to a minimum of five graphic files, each with high/low limits for automatic selection and display of these graphics. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box. Selection for display type shall be individual for each object. Analog object values may be changed by selecting either the "increase" or "decrease" arrow in the analog object spinner box without using the keypad. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trendlogs.
5. Analog objects may also be assigned to an area of a system graphic, where the color of the defined area changes based on the analog object's value. For example, an area of a floor-plan graphic served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint. All editing and area assignment shall be created or modified online using simple icon tools.
6. A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
7. A mouse shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.

H. Password Protection:
   1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.

2. Each operator's terminal shall provide security for 200 users minimum. Each user shall have an individual User ID, User Name and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 0-8 characters, User Name shall be 0-29 characters, and Password shall be 4-8 characters long. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal. Each user shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct security levels for assignment to users.

I. Operator Activity Log:
   1. Operator Activity Log shall be included with system that tracks all operator changes and activities. System shall track what is changed in the system, who performed this change, date and time of system activity and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation.
   2. Log shall be gathered and archived to hard drive on operator workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.
   3. Any displayed data, that is changeable by the operator, may be selected using the right mouse button and the operator activity log shall then be selectable on the screen. Selection of the operator activity log using this method shall show all operator changes of just that displayed data.

J. Scheduling:
   1. Operator's workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily with events being the highest.
   2. Scheduling tool shall allow scheduling of events up to 2 calendar years in advance.
   3. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
   4. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
   5. System shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right clicking on value displayed on graphic and then selecting Schedule.

K. Alarm Indication and Handling:
   1. Operator's workstation shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s), currently running. Printout of alarms shall be sent to the assigned terminal and port.
   2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment and identification of operator acknowledging alarm.
   3. Alarm messages shall be in user-definable text (English or other specified language) and shall be entered either at the operator's terminal or via remote communication.
   4. System shall include an Alarm Wizard for set up of alarms. Wizard shall walk user through all steps necessary for alarm generation. Wizard shall have its own pull-down selection for startup or may be started by right clicking on value displayed on graphic and then selecting alarm setup.

L. Trendlog Information:
   1. System server shall periodically gather historically recorded data stored in the building controllers and field controllers and archive the information Archived files shall be appended with new sample data, allowing samples to be accumulated. Systems that write over archived data shall not be allowed, unless limited file size is specified. Samples may be viewed at the operator's workstation. Operator shall be able to scroll through all trended data. All trendlog information shall be displayed in standard engineering units.
   2. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x, y) graphs that display up to ten object types at the same time in different colors. Graphs shall show object values relative to time.
   3. Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.
   4. System shall include a trend Wizard for setup of logs. Wizard shall walk user through all necessary steps. Wizard shall have its own pull-down selection for startup, or may be started by right clicking on value displayed on graphic, and then selecting Trendlogs from the displayed menu.

M. Energy Log Information:
   1. System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.
   2. All data shall be stored in data base file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
   3. Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
   4. System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format the user shall be able to select a specific period of data to view.

N. Configuration/Setup:
   1. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

O. Field Engineering Tools:
   1. Operator's workstation software shall include field-engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.
   2. User shall be able to pick graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
   3. Programming tools shall include a real time operation mode. Function blocks shall display real time data and be animated to show status of data inputs and outputs when in real

time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.

4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.
5. Field engineering tool shall include Device Manager for automatic detection of devices connected anywhere on the BACnet network by scanning of the entire network. This function shall display device instance, network identification, model number and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer's hard drive. If needed, this file shall be downloaded to the appropriate controller by selection using the mouse.

2.4 NETWORK AREA CONTROLLER (NAC)

A. Network Area Controller (NAC) shall be equal to a Tridium Niagara N4 JACE 8000 or greater with 256 MB of RAM at a minimum. The NAC shall be provided with the necessary BACnet hardware and software for complete integration and functionality.

B. The Network Area Controller (NAC) shall provide the interface between the WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
   1. Calendar functions
   2. Scheduling
   3. Trending
   4. Alarm monitoring and routing
   5. Time synchronization
   6. Integration of BACnet controller data
   7. Network Management functions for all BACnet based devices

C. The NAC must provide the following hardware features as a minimum:
   1. Two Ethernet Ports - 10/100 Mbps
   2. One RS-232 Port
   3. One RS-485 Port
   4. One BACnet Interface Port - 78 KB FTT-10A
   5. Battery Backup
   6. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
   7. The NAC must be capable of operation over a temperature range of 0 to 55°C
   8. The NAC must be capable of withstanding storage temperatures of between 0 and 70°C
   9. The NAC must be capable of operating over a humidity range of 5 to 95% RH, non-condensing

D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

E. The NAC shall support standard web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

F. Event Alarm Notification Actions
   1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.

3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
   a. To alarm
   b. Return to normal
   c. To fault
4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: Critical, HVAC, Energy, etc.
5. Provide timed (schedule) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

G. The following alarms shall be provided for each HVAC system type:

VAV AHU ALARMS	**NAME**	**Alarm Class**	**Annunciation**
Freeze Stat Alarm	TLL_ALM	HVAC	Graphic
High Static Alarm	SA_HS_ALM	HVAC	Graphic
Smoke/Fire Alarm	SF_ALM	HVAC	Graphic
Low Static Alarm	SA_LS_ALM	HVAC	Graphic
AHU ALARMS			
Freeze Stat Alarm	TLL_ALM	HVAC	Graphic
Smoke/Fire Alarm	SF_ALM	HVAC	Graphic
Low Mixed Air Temperature	MA_LOW_T_ALM	HVAC	Graphic

H. Control equipment and network failures shall be treated as alarms and annunciated.

I. Alarms shall be annunciated in any of the following manners as defined by the user:
   1. Screen message text
   2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
      a. Day of week
      b. Time of day
      c. Recipient
   3. Pagers via paging services that initiate a page on receipt of email message
   4. Graphic with flashing alarm object(s)
   5. Printed message, routed directly to a dedicated alarm printer

J. The following shall be recorded by the NAC for each alarm (at a minimum):
   1. Time and date
   2. Location (building, floor, zone, office number, etc.)
   3. Equipment (air handler #, access way, etc.)
   4. Acknowledge time, date, and user who issued acknowledgement.
   5. Number of occurrences since last acknowledgement.

K. Alarm actions may be initiated by user defined programmable objects created for that purpose.

L. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

M. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

N. Provide a "query" feature to allow review of specific alarms by user defined parameters.

O. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

P. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.5 SOFTWARE LICENSE AGREEMENT

A. The controls contractor shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of trade secrets contained within such software.

B. The open license must contain the following statements:
   1. accept.station.in="*"
   2. accept.station.out="*"
   3. accept.wb.in="*"
   4. accept.wb.out="*"

C. Provide a printed copy of the license agreement as part of the submittal package.

2.6 DATA COLLECTION AND STORAGE

A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.

B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
   1. Designating the log as interval or deviation.
   2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
   3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
   4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
   5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

C. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.

D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

E. All log data shall be available to the user in the following data formats:
   1. HTML
   2. XML
   3. Plain Text
   4. Comma or tab separated values

F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

G. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:
   1. Archive on time of day
   2. Archive on user-defined number of data stores in the log (buffer size)
   3. Archive when log has reached its user-defined capacity of data stores
   4. Provide ability to clear logs once archived

2.7 AUDIT LOG

A. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
   1. Time and date
   2. User ID
   3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.8 DATABASE BACKUP AND STORAGE

A. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

B. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.

C. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.9 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Mozilla Firefox™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the EMCS, shall not be acceptable.

C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

D. The Web browser client shall support at a minimum, the following functions:
   1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
   2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
    a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
        (1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
        (2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
    b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
    c. View logs and charts
    d. View and acknowledge alarms
7. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.10 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide “real-time” data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods
1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user’s application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link, i.e., internal, external, hardware, etc.

2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.11 CENTRAL PLANT AND AIR HANDLER APPLICATION CONTROLLERS

A. General:
1. Provide one or more Native BACnet application controllers for each air handler 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 or JACE. No auxiliary or non-BACnet controllers shall be used.

B. BACnet Conformance:
1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as Native BACnet devices. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
   a. Files Functional Group
   b. Reinitialize Functional Group
   c. Device Communications Functional Group
2. Refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include as a minimum-Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 16-bit resolution that accept 10K thermistors, 0-10VDC, 0-5 VDC, 4-20 mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of 3 inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs shall be switch selectable as either 0-10VDC or 0-20mA. Software shall include scaling features for analog outputs. Application controller shall include 24VDC voltage supply for use as power supply to external sensors.

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via Ethernet connection. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

E. Application controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.12 EXPANDABLE CENTRAL PLANT APPLICATION CONTROLLERS

A. General:
1. Expandable application controller shall be capable of providing control strategies for the system based on information from any or all connected inputs. The program that implements these strategies shall be completely flexible and user definable. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site via simple download are not acceptable. Changing global strategies via firmware changes is also unacceptable. Program execution of controller shall be a minimum of once per second.
2. Programming shall be object-oriented using control program blocks. Controller shall support a minimum of 500 Analog Values and 500 Binary Values. Each and every analog and binary value shall support standard BACnet priority arrays. All flowcharts shall be generated and automatically downloaded to controller. No re-entry of database information shall be necessary.
3. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator's terminal or field computer.
4. Controller shall have adequate data storage to ensure high performance and data reliability. Battery shall retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Battery shall be a field-replaceable (non-rechargeable) lithium type. Unused battery life shall be 10 years.
5. The onboard, battery-backed real time clock must support schedule operations and trendlogs.
6. Global control algorithms and automated control functions should execute via 32-bit processor.
7. Controller shall include both on-board 10BASE-T/100BASE-TX Ethernet BACnet communication over twisted pair cable (UTP) and shall include BACnet IP communication. In addition, controller shall include BACnet PTP connection port.
8. The base unit of the controller shall host up to 8 expansion modules with various I/O combinations. These inputs and outputs shall include universal 12-bit inputs, binary triac outputs, and 8-bit switch selectable analog outputs (0-10V or 0-20 mA). Inputs shall support 10K thermistors, 0-5VDC, 0-10VDC, 4-20mA, dry contacts and pulse inputs directly.
9. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.
10. The position of each and every HOA switch shall be available system wide as a BACnet object. Expandable Central Plant Controller shall provide up to 176 discreet inputs/outputs per base unit.

B. BACnet Conformance:
   1. Central Plant/AHU Controller shall as a minimum support Point-to-Point (PTP), MS/TP and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a Native BACnet device and shall support simultaneous routing functions between all supported LAN types. Building controller shall be a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:
   2. Clock Functional Group
      a. Files Functional Group
      b. Reinitialize Functional Group
      c. Device Communications Functional Group
      d. Event Initiation Functional Group
   3. Refer to section 22.2, BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All necessary tools shall be supplied for working with proprietary information.
   4. Standard BACnet object types supported shall include as a minimum: Analog Input, Binary Input, Analog Output, Binary Output, Analog Value, Binary Value, Device, File, Group, Event Enrollment, Notification Class, Program and Schedule object types. All necessary tools shall be supplied for working with proprietary information.
   5. The Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs) and function as a BACnet Broadcast Management Device (BBMD).

C. Schedules:
   1. Each Central Plant/AHU controller shall support a minimum of 50 BACnet Schedule Objects.

D. Logging Capabilities:
   1. Each controller shall support a minimum of 200 trendlogs. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
   2. Controller shall periodically upload trended data to system server for long term archiving if desired.
   3. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

E. Alarm Generation:
   1. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
   2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications.
   3. Controller must be able to handle up to 200 alarm setups stored as BACnet event enrollment objects - system destination and actions individually configurable.

2.13 TERMINAL UNIT APPLICATION CONTROLLERS (ROOFTOPS, HEAT PUMPS, AC UNITS, FAN COILS)

A. General:
   1. 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.

B. BACnet Conformance:
1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a Native BACnet device. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
   a. Files Functional Group
   b. Reinitialize Functional Group
   c. Device Communications Functional Group
2. Refer to section 22.2, BACnet Functional Groups in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include as a minimum-Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
4. Application controllers shall include universal inputs with 16-bit resolution that can accept 10K thermistors, 0-5 VDC, 4-20 mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.
5. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via Ethernet connection. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.
6. Application controller shall include support for intelligent room sensor (see Section 2.9.B.). Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

C. Smoke Detectors:
1. Smoke detectors (duct and area type) shall be provided, installed, and wired into the Fire Alarm System by the Electrical Contractor. The Controls Contractor shall be responsible for interlock wiring between duct smoke detectors and control relays, and starter safety circuits.

2.14 VAV BOX CONTROLLERS-SINGLE DUCT

A. General:
1. Provide one Native BACnet application controller for each VAV box 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 on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. BACnet Conformance:
   1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a Native BACnet device. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
      a. Files Functional Group
      b. Reinitialize Functional Group
      c. Device Communications Functional Group
   2. Refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
   3. Standard BACnet object types supported shall include as a minimum - Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
   4. Application controllers shall include universal inputs with 16-bit resolution that can accept 10K thermistors, 0-5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA or 4-20 mA control signals. Application controller shall include microprocessor driven flow sensor for use in pressure independent control logic. All boxes shall be controlled using pressure independent control algorithms and all flow readings shall be in CFM (LPS if metric).
   5. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via Ethernet connection. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using the same programming tool as Building Controller and as described in operator workstation section. All programming tools shall be provided as part of system.
   6. Application controller shall include support for intelligent room sensor (see Section 2.17.B.). Display on room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence for specific display requirements for intelligent room sensor.
   7. On board flow sensor shall be microprocessor driven and precalibrated at the factory. Precalibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in EEPROM. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator workstation, portable computers and special hand-held field tools shall not be needed for field calibration.
   8. For each VAV box with a reheat coil provide duct temperature sensor at discharge air stream that is connected to controller for reporting back to operator workstation.

2.15 ELECTRONIC ACTUATORS

A. General:
   1. Shall be Electric unless otherwise specified. Shall be manufactured by Belimo. Five-year manufacturer's warranty. Two-year unconditional and three-year product defect from

date of installation.

2. 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.
3. VAV box damper actuation shall be Floating type or Analog (2-10vdc, 4-20ma) and provide to VAV box manufactured for factory installation.
4. Booster-heat valve actuation shall be Floating type or Analog (2-10vdc, 4-20ma).
5. Primary valve control shall be Analog (2-10vdc, 4-20ma).
6. UL Listed Standard 873 and Canadian Standards association Class 481302 shall certify Actuators.
7. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
8. 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.
9. 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.
10. A push button gearbox release shall be provided for all non-spring actuators.
11. Modulating actuators shall be 24VAC and consume 10VA power or less.
12. Conduit connectors are required when specified and when code requires it.

B. Damper Actuators:
   1. Electronic damper actuators shall be direct-coupled rotary type, suitable for mounting directly on the damper end shaft. Electronic damper actuators shall be properly sized to provide sufficient torque to position the damper throughout its operating range. Damper actuators used on economizer and/or outside air dampers shall be spring return.
   2. Terminal unit damper actuators shall be electric, low voltage, utilizing floating control.
   3. 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.
   4. Economizer Actuators shall be provided and installed by EMCS contractor. Actuators shall utilize Analog control 2-10 VDC and shall give position feedback for FDD monitoring. Floating control is not acceptable. Actuators shall be Mechanical Spring Return. Equal to Belimo LF-24-SR.
   5. Electric damper actuators (including VAV box 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.
   6. 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.
   7. 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.)

C. Valve Actuators ½" to 6":
   1. Electronic valve actuators shall be suitable for direct-coupled mounting to the valve bonnet. Valve actuators shall be properly sized to provide sufficient torque to position the valve throughout its operating range. Where butterfly valves are specified, double acting non-spring return actuators may be used. Unless otherwise stated, provide normally open valves for heating water applications and normally closed valves for chilled water applications.

2. Terminal unit reheat valve actuators shall be suitable for direct-coupled mounting to the valve bonnet. Valve actuators shall be properly sized to provide sufficient torque to position the valve throughout its operating range. Non-spring return tri-state floating valve actuators may be used on terminal units where the valve is less than 1 inch.
3. Mechanical spring shall be provided on all actuators for pre-heat coil and actuators for AHU 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.
4. All zone service actuators shall be non-spring return unless otherwise specified.
5. The valve actuator shall be capable of providing the minimum torque required for proper valve close off for the required application.
6. All control valves actuators shall have an attached 3-foot cable for easy installation to a junction box.
7. Override handle and gearbox release shall be provided for all non-spring return valve actuators.

D. Butterfly Valve Industrial Actuators:
1. Actuators shall be approved under Canadian Standards Association or other Nationally Recognized Testing Laboratory to UL standards. CSA Class 4813 02 or equal. Enclosure shall be NEMA 4 (weatherproof) enclosure and will have an industrial quality coating.
2. Actuator shall have a motor rated for continuous duty. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120 VAC, 1-phase, 60 Hz supply. Two adjustable cam actuated end travel limit switches shall be provided to control direction of travel. A self-resetting thermal switch shall be imbedded in the motor for overload protection.
3. Reduction gearing shall be designed to withstand the actual motor stall torque. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.
4. Actuator shall have a 6 ft wiring harness provided for ease in field wiring (above 1500 in-lbs). Two adjustable SPDT cam-actuated auxiliary switches, rated at 250 VAC shall be provided for indication of open and closed position. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.
5. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator and when in manual operation electrical power to the actuator will be permanently interrupted. The hand wheel will not rotate while the actuator is electrically driven.
6. The actuator shall be Analog, floating, or two position as called out in the control sequence of operation. All Analog valves shall be positive positioning, and respond to a 0-10 VDC or 2-10 VDC or 4-20 mA, or adjustable signal as required. Analog actuators shall have a digital control card allowing any voltage input for control and any DC voltage feedback signal for position indication.
7. Performance Verification Test
8. Control loops shall cause productive actuation with each movement of the actuator and actuators shall modulate at a rate which is stable and responsive. Actuator movement shall not occur before the effects of previous movement have affected the sensor.
9. Actuator shall have capability of signaling a trouble alarm when the actuator Stop-Go Ratio exceeds 30%.

2.16 DAMPERS AND VALVES

A. Control Dampers:
1. Control Air dampers shall be parallel blade for two-position control and opposed blade for modulating control applications. Dampers shall be galvanized with nylon bearings. Blade edge and tip seals shall be included for all dampers. Leakage through the damper shall not exceed **4 CFM per square foot at 1" w.c.** Blades shall be 16-gauge minimum

and 10" wide maximum and frame shall be of welded channel iron. Dampers over 48" wide shall be equipped with a jackshaft to provide sufficient force throughout the intended operating range.

2. 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.
3. All dampers used for two-position or open-close control shall be parallel blade type arranged for normally open or closed operation as required.
4. Damper linkage hardware shall be constructed of aluminum or corrosion resistant zinc and nickel-plated steel and furnished as follows:
    a. 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.
    b. 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.

B. Multiple Section Dampers:
1. Size damper sections based on actuator manufacturers specific recommendations for face velocity, differential pressure and damper type. In general:
    a. Damper section shall not exceed 24 ft-sq. with face velocity £ 1500 FPM.
    b. Damper section shall not exceed 18 ft-sq. with face velocity £ 2500 FPM.
    c. Damper section shall not exceed 13 ft-sq. with face velocity £ 3000 FPM.
2. Damper manufacturer shall supply alignment plates for all multi-section dampers.
3. Multiple section dampers of two or more shall be arranged to allow actuators to be direct shaft mounted on the outside of the duct.
4. Multiple section dampers of three or more sections wide shall be arranged with a 3-sided vertical channel (8'' wide by 6" deep) within the duct or fan housing and between adjacent damper sections. Vertical channel shall be anchored at the top and bottom to the fan housing or building structure for support. The sides of each damper frame shall be connected to the channels. Holes in the channel shall allow damper drive blade shafts to pass through channel for direct shaft mounting of actuators. Open side of channel shall be faced down stream of the airflow, except for exhaust air dampers.
5. Multiple section dampers to be mounted flush within a wall or housing opening shall receive either vertical channel supports as described above or sheet metal standout collars. Sheet metal collars (12" minimum) shall bring each damper section out of the wall to allow direct shaft mounting of the actuator on the side of the collar.

C. 333Control Valves:
1. Manufacturer:
    a. Belimo
2. Control Valves
    a. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
3. Characterized Control Valve (CCV)
    a. Forged brass body rated at no less than 600 psi, chrome plated brass ball and stem, female, NPT union ends. No P/T ports required; however, P/T ports on both sides of the valve shall be coordinated with the mechanical contractor.
    b. The modulating control valves shall be pressure independent.
    c. The control valve shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic. The flow shall not vary more than +/- 5% due to system pressure fluctuations across the valve with a minimum of 5 PSID and a maximum of 50 PSID across the valve.

d. Combination of actuator and valve shall provide a minimum close off pressure rating of 200 psi.
e. The application of multiple control valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing of the flow with a single control input signal.
f. The control valve shall require no maintenance and shall not include replaceable cartridges.
g. The manufacturer shall warrant all components for a period of 5 years from the date of substantial completion with the first two years unconditional.

D. Control Valves ½" to 6":
1. Control valves shall be globe type constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Provide two way or three way pattern as shown on the plans. Valves with size up to and including 2-1/2" shall be "screwed". 3" and larger valves shall be "flanged" configuration. Valves larger than 4" shall be butterfly. Water control valves shall be sized for a maximum pressure drop of 5.0 psig at rated flow (except as noted). Two-way control valves shall exhibit equal percentage characteristics. Two-position control valves shall be line size. Ball valves are acceptable for floating or two-position operation where valve size is less than 1 inch.
2. The controls contractor shall furnish all specified motorized control valves and actuators. Controls 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.
3. Characterized Control Valves shall be used for hydronic heating or cooling applications and small to medium AHU water coil applications to 100 GPM. 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. Leakage is Zero percent, Close-off is 200 psi, maximum differential is 30 psi. Rangeability is 500:1.
5. Valves 1/2 inch through 2 inches shall be nickel-plated forged brass body, NPT screw type connections.
6. Valves 1/2 inch through 1-1/4 inches shall be rated for ANSI Class 600 working pressure. Valves 1-1/2 inch and 2 inches shall be rated for ANSI Class 400 working pressure.
7. The operating temperature range shall be 0° to 250° F.
8. Stainless steel ball & stem shall be furnished on all modulating valves.
9. Seats shall be fiberglass reinforced Teflon.
10. Two-way and three-way valves shall have an equal percentage control port. Full stem rotation is required for maximum flow to insure stable BTU control of the coil.
11. Three-way valve shall be applicable for both mixing and diverting.
12. The characterizing disc is made of TEFZEL and shall be keyed and held secure by a retaining ring.
13. The valves shall have a blowout proof stem design.
14. The stem packing shall consist of 2 lubricated O-rings designed for on-off or modulating service and require no maintenance.
15. The valves shall have an ISO type, 4-bolt flange, for mounting actuator in any orientation parallel or perpendicular to the pipe.
16. A non-metallic thermal isolation adapter shall separate valve flange from actuator.
17. One fastening screw shall secure the direct coupling of the thermal isolation adapter between the actuator and the valve. This will prevent all lateral or rotational forces from affecting the stem and its packing O-rings.

E. Globe valves ½" to 2":
1. Shall be used for steam control or water flow applications.
2. Valves shall be bronze body, NPT screw type, and shall be rated for ANSI Class 250 working pressure.

3. Valves 1/2 inch (DN15) through 2 inches (DN50) with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (0.1%).
4. The operating temperature range shall be 20° to 280° F.
5. Spring loaded TFE packing shall protect against leakage at the stem.
6. Two-way valves shall have an equal percentage control port.
7. Three-way valves shall a linear control and bypass port.
8. Mixing and diverting valves must be installed specific to the valve design.

F. Globe Valve 2 ½ to 6":
1. Valves 2-1/2 inch (DN65) through 6 inches (DN50) shall be iron body, 125 lb. flanged with Class III (0.1%) close-off leakage at 50 psi differential.
2. Valves with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (0.1%).
3. Flow type for two-way valves shall be equal percentage. Flow type for three-way valves shall be linear.
4. Mixing and diverting valves must be installed specific to the valve design.

G. Butterfly Valves:
1. Butterfly valves shall be sized for modulating service at 60-70 degree stem rotation. Isolation valves shall be line-size. Design velocity shall be less than 12 feet per second when used with standard EPDM seats.
2. Body is Cast Iron.
3. Disc is Aluminum Bronze standard.
4. Seat is EPDM Standard.
5. Body Pressure is 200 psi, -30°F to 275°F.
6. Flange is ANSI 125/250.
7. Media Temperature Range is -22°F to 240°F.
8. Maximum Differential Pressure is 200 psi for 2" to 6" size.

H. Actuator mounting for damper and valve arrangements shall comply to the following:
1. Damper Actuators: Shall not be installed in the air stream
2. A weather shield shall be used if actuators are located outside. For Damper Actuators use clear plastic enclosure.
3. Damper or valve actuator ambient temperature shall not exceed 122°F through any combination of medium temperature or surrounding air. Appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation shall be provided as necessary.
4. Actuator cords or conduit shall incorporate a drip leg if condensation is possible. Water shall not be allowed to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point shall be avoided to prevent water from condensing in conduit and running into actuator.
5. Damper mounting arrangements shall comply to the following:
6. The ventilation subcontractor shall furnish and install damper channel supports and sheet metal collars.
7. No jack shafting of damper sections shall be allowed.
8. Multi-section dampers shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per section.

I. Valve Sizing for Water Coil:
1. On/Off Control Valves shall be line size.
2. Modulating Control Valve Body Size may be reduced at most two pipe sizes from the line size or not less than ½ the pipe size. The BAS contractor shall size all water coil control valves for the application as follows:
    a. Booster-heat valves shall be sized not to exceed 5 psi differential pressure. Size valve for 50% Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.

b. Primary valves shall be sized not to exceed 5 psi differential pressure. Size valve for 50% Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.
c. Butterfly valves shall be sized for modulating service at 60-70 degree rotation. Design velocity shall be 12 feet per second or less when used with standard EPDM seats.

J. Valve mounting arrangements shall comply to the following:
1. Unions shall be provided on all ports of two-way and three-way valves.
2. Install three-way equal percentage Characterized Control valves in a mixing configuration with the "A" port piped to the coil.
3. Install 2½ inch and above, Three-Way globe valves, as manufactured for mixing or diverting service to the coil.
4. Two-way valve shall be piped in the return side of the coil in order to minimize ambient heat at the coil.

2.17 ENCLOSURES

A. NEMA 2 rated enclosures for inside mounting, provide with weather shield for outside mounting.

B. All controllers, power supplies and relays shall be mounted in enclosures.

C. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

D. Enclosures shall have hinged, locking doors.

E. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8" thick sized appropriately to make label easy to read.

F. All direct digital controllers located indoors shall be installed in NEMA 1 enclosures. All direct digital controllers located outdoors shall be installed in NEMA 3R enclosures. Enclosures shall be of suitable size to accommodate all power supplies, relays and accessories required for the application. Each enclosure shall include a perforated subpanel for direct mounting of the enclosed devices. Include matched key locks for all enclosures provided.

2.18 SENSORS, SWITCHES, CONTROLLERS, TRANSDUCERS, AND MISCELLANEOUS DEVICES

A. Temperature Sensors:
1. All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches above finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day.

B. Wall Sensor
1. Standard wall sensor shall use solid-state sensor and shall be packaged in aesthetically pleasing enclosure. Sensor shall provide port for plug-in of Field Service Tool for field adjustments. All programmable variables shall be available to Field Service Tool through wall sensor port.

C. Field Service Tool:
   1. Field service tool shall allow technician to view and modify all setpoints and tuning parameters stored in application controller. In addition, technician shall be able to view status of all inputs and outputs on digital readout. Each piece of data shall have a data code associated with it that is customizable.
   2. Field service tool shall plug into wall sensor and provide all the functionality specified. Operator workstation shall include the capability to disable operation of the field service tool.
   3. Provide Field Service Tool(s) for this project.

D. Network Connection Tool:
   1. Network connection tool shall allow technician to connect a laptop to any MS/TP network or at any MS/TP device and view and modify all information throughout the entire BACnet network. Laptop connection to tool shall be via Ethernet or PTP.
   2. Provide quick connect to MS/TP LAN at each controller. Tool shall be able to adjust to all MS/TP baud rates specified in the BACnet standard.
   3. Proved 1 Network Connection Tool for this project.

E. Differential Pressure Switches (Air):
   1. Provide differential pressure switches across fans and filters for status indication. Differential pressure switches shall have an adjustable setpoint from 0.05” w.c. to 2” w.c. with a switch differential that progressively increases from 0.02” w.c. at minimum to 0.8” w.c. at maximum. Switch shall be SPDT rated for 15A (non-inductive) at 277VAC.

F. Differential Pressure Switches (Liquid):
   1. Provide differential pressure switches across pumps and chillers to prove flow. Differential pressure switches shall have a 0-150 psig working differential pressure and have an adjustable setpoint from 4” w.c. to 43.5” w.c. on a fall and 5.5” w.c. to 45” w.c. on a rise. Liquid differential pressure switch enclosure shall carry a NEMA 4 rating. Switch shall be SPDT rated for 5A (inductive) at 125VAC.

G. Float Switches:
   1. Provide float switches in condensate drain pans as required by code. Float switches shall utilize a magnetically actuated dry reed switch. Float shall be constructed of seamless polypropylene. Switch shall be SPDT rated for 16A (non-inductive) at 120VAC.

H. Mixed Air Low Limit Controllers (Freezestats):
   1. Mixed air low limit controllers shall be manual reset, adjustable setpoint with 20-foot element serpentined across the entering air face of center cooling coil. Control shall be responsive only to the lowest temperature along the element.

I. Static High Limit Controllers:
   1. Discharge static high limit controllers shall be provided on all VAV AHU systems. When discharge static pressure exceeds setpoint, the supply fan shall be de-energized. Manual reset shall be required.

J. Static Pressure Transducers (Air):
   1. Provide static pressure transducers for monitoring supply duct static pressure. Static pressure transducers shall be 100% solid state and shall include glass on silicon, ultra-stable capacitance sensors. Each static pressure transducer shall incorporate short circuit and reverse polarity protection. Transmitter output shall be either 0-10VDC or 4-20mA. Static pressure transducers are to be provided in an enclosure that is suitable for duct mounting. The desired setpoint is to be in the top 50% of the transmitter’s operating range.

K. Differential Pressure Transducers (Air):
   1. Provide differential pressure transducers for monitoring air system and airflow measuring station differential pressures. Differential pressure transducers shall be 100% solid state and shall include glass on silicon, ultra-stable capacitance sensors. Each differential pressure transducer shall incorporate short circuit and reverse polarity protection. Transducer output shall be either 0-10VDC or 4-20mA. Differential pressure transducers are to be provided in an enclosure that is suitable for duct mounting. The desired setpoint is to be in the top 50% of the transducer's operating range.

L. Line Pressure Transducers (Liquid):
   1. Provide Rosemount 3051 line pressure transducers for monitoring hydronic system line pressure. Pressure transducers shall be 100% solid state with accuracy of +/- 1% of calibration range. Factory calibrated and have zero and span trimmers for field calibration. Range shall be selected to match the medium being monitored. Transducer output shall be either 0-10VDC or 4-20mA. Differential pressure transducers are to be provided in a field mounted enclosure and all wetted parts shall be constructed from materials that are suitable for operation in the measured medium. LCD display.

M. Differential Pressure Transducers (Liquid):
   1. Provide Rosemount 3051 pressure differential transducers for monitoring hydronic system differential pressure. Differential pressure transducers shall be 100% solid state with accuracy of +/- 1% of calibration range and shall include dual silicon water type sensors. Factory calibrated and have zero and span trimmers for field calibration. Pressure snubbers to protect from pressure pulses and a 3-way bypass / valve assembly to protect the transducer from overpressure damage during start-up. Range shall be selected to match the medium being monitored. Transducer output shall be either 0-10VDC or 4-20mA. Differential pressure transducers are to be provided in a field mounted enclosure and all wetted parts shall be constructed from materials that are suitable for operation in the measured medium. LCD display.

N. Airflow Measuring Stations:
   1. Where shown on the plans, provide airflow measuring stations utilizing multiple point averaging sensors for total pressure measurement and bullet-nose probes for static pressure measurement. Airflow measuring stations shall be factory assembled units with a sheet metal casing of at least 16 gauge galvanized steel. Airflow measuring stations shall be equipped with 3/8" aluminum hexagon cell straightening vanes. Pressure drop across airflow measuring station shall be less than 0.13" w.c. at 2000 FPM with the straightening vanes installed. Accuracy of airflow measurement shall be +/- 2% at 6000 FPM inlet velocity and +/- 0.5% at 2000 FPM inlet velocity.

O. Liquid Flow Meters:
   1. Provide insertion type flow meters for monitoring system hydronic system flow. Flow meters shall be 100% solid state and shall include paddle type non-magnetic, non-photoelectric sensors. Flow meters shall be provided with "hot tap" isolation valves and all accessories for bi-directional flow. Flow meter transmitter supply voltage to be 24VAC unregulated. Flow meter output shall have either a 4-20mA or pulse output that is linear with the flow rate.

P. Current Sensing Relays:
   1. Provide current switches for indication of equipment status. Amperage ratings shall be adjustable with the desired setpoint to be in the top 50% of the current relay's operating range. Current sensing relays shall incorporate trip indication LED's and shall be sized for proper operation with the equipment served.

Q. Relative Humidity Sensors:
1. Relative humidity sensors shall have an accuracy of +/- 3% from 5 to 95% RH. Output signal shall be either be 0-10VDC or 4-20mA. Humidity transmitters shall be factory calibrated and require no field setting.

R. CO2 Sensors:
1. CO2 sensors shall be space or duct mounted carbon dioxide sensors as required by the application. Space CO2 sensors shall be mounted next to space temperature sensors. The sensor shall have a range of 0-2000 ppm with an accuracy of ±5%. The response time for the sensor shall be less than one minute. The sensor shall be capable of providing an analog signal proportional to the CO2 level sensed. The signal shall be either 0-10VDC or 4-20mA.

S. Duct/Well Sensors:
1. Sensors for duct and water temperature sensing shall incorporate either RTD or Thermistor sensing devices. Sensing element accuracy shall be 0.1% over the sensor span or better. Where the element is being used for sensing mixed air or coil discharge temperatures and/or the duct cross sectional area is in excess of 14 square feet, the element shall be of the averaging type. Averaging duct sensors shall utilize a 6, 12 or 24 foot sensing element. Immersion sensors shall use matched 316 stainless steel bulb wells. All duct and immersion sensors shall be provided with conduit connection housings. Sensors shall be provided with adequate standoffs for insulation installation.

T. Selector Switches:
1. Selector switches shall be 2 or 3-position, knob or key type as required by the sequence of operation. Selector switches shall feature oil tight construction and be fitted with snap-fit contact blocks rated for 10A, 600VAC/DC operation. Labels shall be provided indicating switch position.

U. Pushbutton Switches:
1. Pushbutton switches shall be either maintained or momentary as required by the sequence of operation. Pushbutton switches shall feature oil tight construction and be fitted with snap-fit contact blocks rated for 10A, 600VAC/DC operation. Labels shall be provided indicating switch function.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the owners' representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

D. Each bid must include all costs associated with providing wiring, conduit, concrete trenching, and earth trenching.

3.2 OPERATION

A. BACnet Object List:
1. The following points as defined for each piece of equipment are designated as follows:
a. Binary Out (BO) - Defined as any two-state output (start/stop) (enable/disable), etc.

b. Binary In (BI) - Defined as any two-state input (alarm, status), etc.
c. Analog In (AI) - Defined as any variable input (temperature) (position), etc.
d. Analog Out (AO) - Defined as any electrical variable output. 0-20mA, 4-20mA and 0-10VDC are the only acceptable analog outputs. The driver for analog outputs must come from both hardware and software resident in the controllers. Transducers will not be acceptable under any circumstance.

2. Each and every point will be checked out by the Contractor and the Owner's Representative will inspect each point with the bidder prior to acceptance. Provide complete written documented inspections, test and checkout report. Calibrate all equipment.

B. DDC Object Type Summary:
1. Provide all database generation.
2. Displays:
a. System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air temperature indication on all system displays associated with economizer cycles.
3. Run Time Totalization:
a. At a minimum, run time totalization shall be incorporated for each monitored supply fan, return fan, exhaust fan, hot water and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.
4. Trendlog:
a. All binary and analog object types (including zones) shall have the capability to be automatically trended.
5. Alarm:
a. All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.
6. Database Save:
a. Provide back-up database for all stand-alone application controllers on disk.

3.3 INSTALLATION

A. General:
1. Install in accordance with manufacturer's instructions.
2. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.
3. Provide a complete and operational temperature control and building automation system based on the following points and sequence of operation. The system shall be complete as to sequences and standard control practices. The determined point list is the minimum amount of points that are to be provided. If additional points are required to meet the sequence of operation, they will be provided.

B. Location and Installation of Components:
1. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units. Obtain approval on locations from owner’s representative prior to installation.
2. Enclosures and hardware or wiring shall not block or limit accessibility to service compartments of any other equipment.
3. The work shall be coordinated fully, as it pertains to the fire protection system, fire alarm system, and electrical power system. All items shall be terminated in the DDC controllers in a predetermined order as indicated in the submittal drawings.
4. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.
5. Identify all equipment and panels. Provide permanently mounted tags for all panels.

6. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections - sized to suit pipe diameter without restricting flow.

C. Interlocking and Control Wiring:
   1. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state and local electrical codes.
   2. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks. Communication shall be per manufacturer's specifications.
   3. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.
   4. Provide auxiliary pilot duty relays on motor starters as required for control function.
   5. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings. Coordinate with electrical contractor.
   6. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in conduit. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum rated cable (without conduit).

D. Installation Requirements:
   1. Any panels associated with the control system shall be furnished and installed under this section of the work. Panel wiring shall be terminated by connecting to numbered terminals strips. Wire nut connections shall not be allowed. All wiring shall be color coded and shall be tagged for future identification.
   2. Unless otherwise specified, all devices, panels, etc., furnished and/or installed by the Contractor shall be located where they can be calibrated and maintained from the floor without use of a ladder. These items shall be identified by means of plates made of plastic suitably engraved, embossed or punched, plastic tape will not be acceptable. At completion of job, the Contractor shall submit record drawings of any changes made during construction. This submittal shall be a condition of final payment.
   3. Any conduit on roof shall be absolute minimum and shall have prior written approval.
   4. All conduit used indoor and outdoor shall be metal and shall be of type and fittings to minimize corrosion and moisture entry.

E. Cable Installation and Attachments:
   1. Control System wiring and equipment installation shall be in accordance with good engineering practices as established by the TIA/EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts. All cable shall be supported from the building structure and bundled.
   2. The support system shall provide a protective pathway to eliminate stress that could damage the cabling. The cable shall not be crushed, deformed, skinned, crimped, twisted, or formed into tight radius bends that could compromise the integrity of the cabling. Controls cables shall not be run loose on ceiling grid or ceiling tiles. Support shall be provided by mounting appropriate fasteners which may be loaded with multiple cables. Provided that the weight load is carried by the support rod or wire, the support assembly may attach to the ceiling grid for lateral stabilization. The required support wires for the ceiling grid or light fixtures shall not be utilized. Any fastener attached to the ceiling grid shall not interfere with inserting or removing ceiling tiles. All cabling and supports must be positioned at least 12 inches above the ceiling grid.
   3. Controls cables shall be run in bundles above accessible ceilings and supported from building structure. Cabling shall be loosely bundled with wire wraps randomly spaced at 30 to 48 inches on center, wire wraps shall not be tight enough to deform cabling and

shall not be used to support the cabling.

4. Attachments for cabling support shall be spaced at 48 to 60 inches on center. The cable bundle shall not be allowed to sag more than 12 inches mid-span between attachments. Attachments shall be sized as follows:

Bundles up to 1/2" dia. (Ten 1/4" cables)	2" bridle ring, Caddy #4BRT32 or equivalent
Bundles up to 3/4" dia. (Sixteen 1/4" cables)	3/4" J-Hook, Caddy #CAT12 or equivalent
Bundles up to 1-5/16" dia. (Fifty 1/4" cables)	1-5/16" J-Hook, Caddy #CAT21 or equivalent
Bundles up to 2" dia. (Eighty 1/4" cables)	2" J-Hook, Caddy #CAT21 or equivalent

   Split bundles greater than 2" dia. or provide cable tray.
5. Do not mix different signal strength cables on the same J-Hook (i.e. fire alarm, 25 volt speaker cable). Multiple J-Hooks can be on the same attachment point up to the rated weight of the attachment device.
6. Controls cables shall be run in conduit stubs, where stubs are provided, from wall mounted devices to above accessible ceilings. Conduit shall be required only within walls and concealed spaces to provide access. Provide a plastic snap bushing or sleeve on the end of each conduit stub such as Thomas & Betts Catalog no. 443 - 3/4", 424 - 1", 425 - 1 1/4", 427 - 2" or equivalent.
7. Conduit, duct or track shall be used for controls cable in exposed areas.
8. All conduit, ducts, track and raceways shall be supported from the structure at industry standard intervals for the size specified, utilizing proper anchoring devices and techniques for each type of cable used.
9. All penetrations through fire rated walls or floors shall feature a short length of metal conduit. The hole shall be neatly cut, not oversize or irregular. Seal the interior of the conduit sleeve around the cables and around the outside of the sleeve on each side of the penetration with fire-stop caulk or putty, such as Minnesota Mining & Mfg. Co. (3M) - CP 25WB+ caulk, MPS-2+ putty, or equivalent. Install according to the manufacturers' instructions.
10. All cable shall have a label on both ends utilizing self-laminating, flexible vinyl film and non-smear nylon marking pens. Utilize Tyton Corporation Part No. RO175 Rite-On labels and Part No. FTP1 nylon marking pens or equivalent.
11. Each cable run shall include a three foot service loop with wire tie located in the ceiling above the control unit panel. This is to allow for future re-termination or repair.
12. No terminations or splices shall be installed in or above ceilings. Cable shall be continuous from one device termination to the next.
13. Mount all equipment firmly in place. Route cable in a professional, neat and orderly installation.
14. All cabling shall be placed with regard to the environment, EMI/RFI (interference) and its effect on communication signal transmission.
15. Do not route any controls cable within two feet of any light fixture, HVAC unit service access area, electric panel, or any device containing a motor or transformer.
16. Low voltage controls cable will not be installed in the same conduit, duct or track with line voltage electrical cable.
17. Maximum pulling tension should not exceed 25 lb/ft. or manufactures recommendation, whichever is less.
18. Any pulling compounds utilized must be approved by the cable manufacturer and shall not degrade the strength or electrical characteristics of the cable.
19. Cable bends shall not exceed the manufacturers' suggested bend radius.
20. Provide for adequate ventilation in all equipment panels.
21. Provide wiremold where wiring must run exposed. Obtain advance approval from Architect and Owner before running exposed. Coordinate with Owner and Architect.
22. For all wiring, provide numbering on all terminations (both ends).

23. Label all panels, cans, enclosures, controllers and correlate with air conditioning units served. Labeling shall relate to shop drawings and equipment served. Provide wiring diagram inside each enclosure.
24. Provide a rain-tight enclosure for each rooftop unit controller.
25. Locate outdoor air sensors shielded and on northern exposure.

F. Termination practices:
1. Strip back only as much cable jacket as required to terminate.
2. Preserve wire twists as closely as possible to point of termination (0.5" maximum) to keep signal impairment to a minimum.
3. Avoid twisting cable during installation.
4. Electrical Interlocks:
a. All electrical interlocks shall be provided as specified. All electrical interlocks shall be made by means of motor starters or shall be accomplished by separate relays. No motor power lead shall be utilized in an interlock circuit.

3.4 SERVICES

A. Field Services:
1. Prepare and start logic control system under provisions of this section.
2. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
3. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide remote access via Internet for this service for 1 year or as specified.
4. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.
5. Provide all interface devices and computer cards required.
6. Contractor responsible for verifying all quantities of air conditioning units, etc. on existing and new construction.
7. Provide Owner with CD or flash drive with graphic diagrams and drawings. Include map of Campus with buildings located and floor plan of each building with equipment located.
8. This Contractor shall provide a Project Manager with a minimum of 3 years' experience with installation and set-up of the equipment of the Bidder/Manufacturer they represent.

B. HVAC Training:
1. Provide application engineer to instruct owner in operation of systems and equipment.
2. Provide system operator's training to include (but not limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of 3 persons.
3. Provide on-site training above as required, up to 8 hours as part of this contract.

C. Demonstration:
1. Provide systems demonstration under provisions of Section 23 00 00.
2. Demonstrate complete operating system to owner's representative.
3. Provide certificate stating that control system has been tested and adjusted for proper operation.

D. Programming:
1. Prior to completion of the control installation, schedule time with Owner's designated representatives to evaluate and select programming options and requirements. Contractor shall provide engineer for such meetings and consultations on an as-needed basis. Preparation time for the conference shall be in addition to the "in conference" time, and shall be provided on an as-needed basis without additional cost to the Owner.

2. The Contractor shall also provide additional coordination as needed with the Owner's representative and Engineer to formulate and determine functions, reports, graphics, and alarms most desirable and suitable for the school district and writing the software capability. Programming of these items shall be provided. The Contractor shall program the system using coordinated Owner provided schedules for time of day and holidays.
3. No hardware change shall be required for program changes.

E. Documentation:
1. The Contractor shall provide a complete documentation package to the owner which shall include floor plans indicating location of EMCS equipment, wiring diagrams, bill of materials, data base information, and sequences of operation. The sequences of operation shall be submitted and approved by the owner in writing prior to installation and programming.

F. Coordination:
1. For construction project installations where electrical and mechanical contractors are responsible for their respective trade, the electrical contractor is to provide line voltage to required equipment and the mechanical contractor is to install any devices that are to be included in piping systems. It is the controls contractor responsibility to provide all devices with diagrams for location and coordinate with mechanical contractor prior to mechanical contractor starting installations. For installations where controls only, work is provided, all necessary work shall be performed by the controls contractor. Controls contractor shall coordinate and provide all required work and wiring for duct mounted smoke detectors, control relays for unit shutdown, and interface with any fire alarm system. For installations where controls only work is provided, all necessary work shall be performed by the controls contractor.

PART 4 SEQUENCE OF OPERATION

4.1 SEQUENCE OF OPERATION

A. The following are sequences of operations which will be accomplished by the EMCS. Coordinate with Owner in operating equipment to maximize comfort and economy. All points required to accomplish the sequences will be provided and connected to the EMCS.

B. DDC Control - Rooftop Units, Split Systems and DX Units, and Heat Pumps: Each unit shall be started and stopped by the EMCS. Automatic override during low or high ambient temperatures shall be provided. Provide one outdoor air sensor per school. Provide an indoor air space sensor for every unit to monitor space temperature, and be capable of remote resetting space temperature by Owner.

C. Provide one outside air relative humidity sensor and temperature sensor per campus. It is also acceptable to obtain outside air ambient conditions from a nearby weather station.

D. ACRONYMS:

EMCS	Energy Management Control System. The EMCS controls all of the HVAC functions as well as lighting schedules and lawn sprinkler schedules.
TCS	Temperature Control Sensor. This is the device that controls the temperature in the space.
VFD	Variable Frequency Drive.
DDC	Direct Digital Control.
OAU	Outside Air Unit.
CO_2	Carbon Dioxide.
CFM	Cubic Feet per Minute
GPM	Gallons Per Minute

A/H	Air Handler
F/C	Fan Coil Unit
CHW	Chilled Water
HW	Hot Water
VAV	Variable Air Volume
UCP	Unit Control Panel
ppm	Parts Per Million - A measurement of the concentration of one substance within another. In this case, it is the number of CO2 particles in a sample of one million air particles.
Adj	Adjustable - All set points are assumed to be adjustable whether specified or not. The set points specified are values that should be programmed initially but can be changed if necessary.

E. DEFINITIONS:
1. Occupancy Period:
   a. The period of the day that the owner wants the environmental conditions acceptable for occupancy. Outside air ventilation may not be enabled at all times during the occupancy period. This schedule will be defined for each component of the HVAC system and will not be the same for all components.
2. Outside Air Schedule:
   a. The period of the day that outside air ventilation is enabled. This schedule will be defined for each component of the HVAC system.
3. Warm-up Mode:
   a. The time between the end of the unoccupied and start of the occupied period during which the space temperature is increased (night setback) to the normal occupancy temperature.
4. Cool-down Mode:
   a. The time between the end of the unoccupied and start of the occupied period during which the space temperature is lowered (night setup) to the normal occupied temperature.
5. Unoccupied Period:
   a. The period of the day that the temperature control setting is lowered (heating) or raised (cooling) to conserve on the amount of energy required to condition the building. The fans are also turned “OFF” to conserve energy.

F. DOCUMENTATION
1. The Contractor shall provide a complete documentation package to the owner which shall include floor plans indicating location of EMCS equipment, wiring diagrams, bill of materials, data base information, and sequences of operation. The sequences of operation shall be submitted and approved by the owner in writing prior to installation and programming.

4.2 SINGLE ZONE DX RTU WITH IONIZER

A. GENERAL:
1. System consists of a direct expansion (DX) cooling section, heating section, supply fan section and an outside air damper.

B. UNIT ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule.
2. During unoccupied times, as required to maintain the unoccupied heating and cooling setpoints 55°F (adj.) heating and 85°F (adj.) cooling as sensed by the space temperature sensor.

3. When the override pushbutton is depressed, the unit shall be indexed to the occupied mode for an adjustable period of time (initially 1 hour). After the override time period has expired, the unit shall revert back to the unoccupied mode.

C. FAN CONTROL:
1. Fan speed shall be controlled by the unit's internal controls. If unit requires fan speed to be controlled by external source, contractor to provide everything necessary to achieve fan control as noted below.
   a. Fan shall run in low speed during first stage heating or cooling as set by TAB.
   b. Fan shall run in high speed during second stage heating or cooling as set by TAB.

D. OUTSIDE AIR DAMPER CONTROL:
1. Warm-up or Cool-down:
   a. The outside air damper shall be closed.
2. Occupied Mode:
   a. The outside air damper shall be at the minimum position (adj.) as set by TAB
3. Unoccupied Mode:
   a. The outside air damper shall be closed.

E. TEMPERATURE CONTROL:
1. Warm-up or Cool-down:
   a. The EMCS shall determine the required warm-up or cool-down period based on the optimized start algorithm.
   b. Upon enabling the unit, the unit shall heat and cool as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor.
   c. Once the occupied setpoint temperature has been reached, the EMCS shall switch the unit to the occupied mode.
2. Occupied Mode:
   a. Space set point shall be user adjustable within ±2°F (adj.).
   b. In the occupied mode of operation, the unit supply fan shall cycle with a call for heating or cooling.
   c. The unit shall heat and cool as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor.
   d. When space temperature rises above occupied cooling setpoint, the DDC controller shall energize the first stage of mechanical cooling. First stage cooling shall have a 20-minute (adj.) runtime before allowing second stage to engage. When space temperature continues to rise 2°F (adj.) above occupied cooling setpoint, the DDC controller shall energize the second stage of mechanical cooling.
      (1) First stage cooling – Low speed supply CFM and first stage of compressor(s)
      (2) Second stage cooling – High speed supply CFM and second stage of compressor(s)
         - Unit shall run in second stage cooling until space temperature drops to occupied space cooling setpoint. Unit shall then run in first stage of cooling until space temperature drops 1°F (adj.) below space temperature setpoint and then cycle off.
   e. When space temperature drops below occupied heating setpoint, the DDC controller shall energize the first stage of heating. When space temperature continues to drop 2°F (adj.) below occupied heating setpoint, the DDC controller shall energize the second stage of heating.
      (1) First stage heating – Low speed supply CFM and first stage of heating.
      (2) Second stage heating – High speed supply CFM and second stage of heating.

- Unit shall run in second stage heating until space temperature rises to occupied space heating setpoint. Unit shall then run in first stage heating until space temperature rises 1°F (adj.) above space temperature setpoint and then cycle off.

3. Unoccupied Mode:
   a. The EMCS shall enable the unit as required to maintain the unoccupied heating and cooling setpoints (initially 55°F heating and 85°F cooling) as sensed by the space temperature sensor.
   b. When override button is pushed, the unit shall index to occupied mode for one (1) hour (adj.). After the override time has expired, the unit shall revert to unoccupied mode.

F. DRY BULB ECONOMIZER MODE:
   1. In occupied or unoccupied mode, when space temperature is above space setpoint, outside air temperature is 60°F (adj.) or below and there is a call for cooling, the unit shall be in economizer mode. Outside air damper is to open 100% and to provide free cooling to the space until the space temperature setpoint is satisfied. If space is not satisfied within 10 min (adj.), mechanical cooling will be enabled.
   2. Units equipped with a powered exhaust fan, the fan is to be enabled any time the unit is in economizer mode.
   3. All sensors necessary for economizer mode operation and FDD shall be provided and fully controlled by EMCS contractor

G. DEHUMIDIFICATION MODE (Only applies to units with hot gas bypass):
   1. Hot Gas Re-heat:
      a. Dehumidification mode shall be energized when the space temperature setpoint is satisfied and the space relative humidity is above 58% (adj.). Dehumidification shall disable when space relative humidity is 2% (adj.) below humidity setpoint.

H. FAULT DETECTION AND DIAGNOSTICS (FDD)
   1. Each DX rooftop unit shall have its economizer status monitored by the EMCS. The unit's fault detection and diagnostics shall be capable of generating a visible alarm to be seen by the EMCS should the unit be in economizer when conditions are not met, or vice versa

I. CONTROL POINTS:

Description	Type
Fan Amps/Status	AI
Compressor Amps/Status (Each Compressor)	AI
Mixed Air Temperature	AI
Supply Air Temperature	AI
Outside Air Temperature (Global)	AI
Space Temperature	AI
Space Humidity (Only Units with Hot Gas Bypass)	AI
Bipolar Ionization Status	DI
Outside Air Damper Feedback	AI
Fan Start/Stop Command (Each Fan)	DO
Fan Speed (Only If Required by Unit)	AO
Compressor Cooling Command (Each Stage)	DO
Heating Command (Each Stage)	DO
Hot Gas Bypass Reheat (Only Units with Feature)	DO
Outside Air Damper	AO

4.3 CONTROL

A. BUILDING ELECTRICAL
1. General:
a. Provide digital monitoring of building MSB. The EMCS shall monitor the electrical energy consumption at the buildings main electric feed. Coordinate with switchgear manufacturer and/or electrical contractor.
b. Provide dashboard with daily, weekly, monthly, and yearly usage totals
2. Control Points:

Description	Type
KVA	AI
KWH	AI
Demand	AI
Power Factor	AI
Voltage	AI

B. EXTERIOR LIGHTING
1. General:
a. Provide auxiliary contactor(s) to control lighting. Include all hardware and software required and connect to nearest EMCS controller. Coordinate with electrical contractor.
2. Control Points:

Description	Type
Photocell	AI/DI
Lighting Contactor	DO

C. KITCHEN COOLER/FREEZER MONITORING
1. General:
a. The walk-in cooler and the walk-in freezer shall each be monitored for space temperature. The EMCS shall generate an alarm should the space temperature exceed or drop below its assigned alarm limits (adj.).
2. Control Points:

Description	Type
Cooler Temperature	AI
Freezer Temperature	AI

D. AMBIENT CONDITIONS
1. General:
a. The EMCS shall monitor the ambient outside conditions at the building. Sensors shall be located outside the building for northern exposure.
2. Control Points:

Description	Type
Outside Temperature	AI
Outside Humidity	AI
Outside CO2	AI

E. GANG TOILET EXHAUST FANS
1. General:
a. Fans to be disabled/enabled by the EMCS based on a time schedule.
2. Control Points:

Description	Type
Fan Amps/Status (Each Fan)	AI
Fan Start/Stop Command (Each Fan)	DO

F. ELECTRICAL ROOM EXHAUST FANS
1. General:
   a. The EMCS to monitor space temperature for all electrical rooms with exhaust fans. The electrical room exhaust fans are to operate continuously when the space above 80° F (adj.).
2. Control Points:

Description	Type
Fan Amps/Status (Each Fan)	AI
Space Temperature (Each Room)	AI
Fan Start/Stop Command (Each Fan)	DO

G. CRAWLSPACE EXHAUST FANS
1. General:
   a. The EMCS to measure crawlspace temperature and humidity. Calculations are to be done to find dewpoint of crawlspace and ambient dewpoint. The crawlspace fans are to operate continuously when the crawlspace dewpoint is above 60° F (adj.) and ambient dewpoint is less than crawlspace dewpoint.
2. Control Points:

Description	Type
Crawlspace Temperature	AI
Crawlspace Humidity	AI
Fan Amps/Status (Each Fan)	AI
Fan Start/Stop Command (Each Fan)	DO

H. VARIABLE FREQUENCY DRIVES
1. General:
   a. The EMCS shall interface and monitor points from the VFDs.
   b. VFD interfaces shall be achieved via BACnet communication link.
   c. VFD data to be shown on associated unitary graphic.
   d. Provide dashboard with daily, weekly, monthly, and yearly usage totals for KWH and Runtime
2. Control Points:

Description	Type
Start/Stop (Each VFD)	DI
Alarm (Each VFD)	DI
Percent Output (Each VFD)	AI
Frequency Output (Each VFD)	AI
Amperage (Each VFD)	AI
KWH (Each VFD)	AI
Runtime (Each VFD)	AI

I. MDF/IDF ROOMS
1. GENERAL:
   a. The EMCS shall monitor space temperature for all MDF/IDF rooms. The EMCS shall generate an alarm should the space temperature exceed or drop below its assigned alarm limits (adj.).

2. Control Points:

Description	Type
Space Temperature (Each Room)	AI

4.4 FAN COIL UNIT (CHILLED WATER COIL AND HOT WATER PREHEAT COIL)

A. GENERAL:
1. The fan coil unit shall be provided with a filter, supply fan, chilled water valve, hot water valve and outside air damper. The control system contractor shall provide a dedicated stand-alone DDC controller for each unit.

B. UNIT ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule.
2. During unoccupied times, as required to maintain the unoccupied heating and cooling setpoints 55°F (adj.) heating and 85°F (adj.) cooling as sensed by the space temperature sensor.
3. When the override pushbutton is depressed, the unit shall be indexed to the occupied mode for an adjustable period of time (initially 1 hour). After the override time period has expired, the unit shall revert back to the unoccupied mode.

C. TEMPERATURE CONTROL:
1. Warm-up or Cool-down:
   a. The EMCS shall determine the required warm-up or cool-down period based on the optimized start algorithm.
   b. Upon enabling the unit, the unit shall heat and cool as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor.
   c. During warm-up, the supply air discharge temperature shall be 90°F (adj.). During cool-down, the supply air temperature shall be 55°F (adj.).
   d. Once the occupied setpoint temperature has been reached, the EMCS shall switch the unit to the occupied mode.
2. Occupied Mode:
   a. Space set point shall be user adjustable within ±2°F (adj.).
   b. In the occupied mode of operation, the unit supply fan shall cycle with a call for heating or cooling.
   c. The unit shall heat and cool as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor.
   d. When space temperature is below heating setpoint, the unit is in heating mode. The heat valve will modulate to maintain space temperature and discharge temperature of no more than 90°F (adj.)
   e. When space temperature is above cooling setpoint, the unit is in cooling mode. The chilled water valve shall modulate to maintain a constant supply air temperature setpoint of 55°F (adj.).
3. Unoccupied Mode:
   a. The EMCS shall enable the unit as required to maintain the unoccupied heating and cooling setpoints (initially 55°F heating and 85°F cooling) as sensed by the space temperature sensor.

D. OUTSIDE AIR DAMPER CONTROL:
1. Warm-up or Cool-down:
   a. The outside air damper shall be closed.
2. Occupied Mode:
   a. The outside air damper shall be at the minimum position (adj.) as set by TAB

3. Unoccupied Mode:
   a. The outside air damper shall be closed

E. SAFETIES:
1. Freeze Protection:
   a. When the outside air (OA) temperature drops below 36°F (adj.), chilled water and hot water valves will be open to 20%.
   b. When the OA temperature rises 2°F above freeze protection setpoint for one hour, the reverse shall occur.

F. CONTROL POINTS:

Description	Type
Fan Amps/Status	AI
Mixed Air Temperature	AI
Supply Air Temperature	AI
Space Temperature	AI
Space CO2	AI
Drain Pan Switch	DI
Bipolar Ionization Status (If Scheduled/Equipped)	DI
Chilled Water Valve	AO
Hot Water Valve	AO
Fan Start/Stop Command	DO
Outside Air Damper	AO

4.5 HEAT PUMP SPLIT SYSTEM – DX AND HEAT AND IONIZER

A. GENERAL:
1. The heat pump unit shall be provided with a filter, supply fan, cooling/heating coil, auxiliary heat and outside air damper. The control system contractor shall provide a dedicated stand-alone DDC controller for each unit.

B. UNIT ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule.
2. During unoccupied times, as required to maintain the unoccupied heating and cooling setpoints 55°F (adj.) heating and 85°F (adj.) cooling as sensed by the space temperature sensor.
3. When the override pushbutton is depressed, the unit shall be indexed to the occupied mode for an adjustable period of time (initially 1 hour). After the override time period has expired, the unit shall revert back to the unoccupied mode.

C. FAN CONTROL:
1. Fan speed shall be controlled by the unit's internal controls.

D. OUTSIDE AIR DAMPER CONTROL:
1. Warm-up or Cool-down:
   a. The outside air damper shall be closed.
2. Occupied Mode:
   a. The outside air damper shall be at the minimum position (adj.) as set by TAB
3. Unoccupied Mode:
   a. The outside air damper shall be closed.

E. TEMPERATURE CONTROL:
1. Warm-up or Cool-down:
a. The EMCS shall determine the required warm-up or cool-down period based on the optimized start algorithm.
b. Upon enabling the unit, the unit shall heat and cool as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor.
c. Once the occupied setpoint temperature has been reached, the EMCS shall switch the unit to the occupied mode.
2. Occupied Mode:
a. Space set point shall be user adjustable within ±2°F (adj.).
b. In the occupied mode of operation, the unit supply fan shall cycle with a call for heating or cooling.
c. The unit shall heat and cool as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor.
d. When space temperature rises above occupied cooling setpoint, the DDC controller shall energize the first stage of mechanical cooling. First stage cooling shall have a 20-minute (adj.) runtime before allowing second stage to engage. When space temperature continues to rise 2°F (adj.) above occupied cooling setpoint, the DDC controller shall energize the second stage of mechanical cooling.
(1) First stage cooling – Low speed supply CFM and first stage of compressor(s).
- Second stage cooling – High speed supply CFM and second stage of compressor(s).
- Unit shall run in second stage cooling until space temperature drops to occupied space cooling setpoint. Unit shall then run in first stage of cooling until space temperature drops 1°F (adj.) below space temperature setpoint and then cycle off.

e. When space temperature drops below occupied heating setpoint, the DDC controller shall energize the first stage of heat. When space temperature continues to drop 2°F (adj.) below occupied heat setpoint, the DDC controller shall energize the second stage of heat.
(1) First stage heating – Low speed supply CFM and first stage of heat.
(2) Second stage heating – High speed supply CFM and second stage of heating.
- Unit shall run in second stage heating until space temperature rises to occupied space heating setpoint. Unit shall then run in first stage heating until space temperature rises 1°F (adj.) above space temperature setpoint and then cycle off.

3. Unoccupied Mode:
a. The EMCS shall enable the unit as required to maintain the unoccupied heating and cooling setpoints (initially 55°F heating and 85°F cooling) as sensed by the space temperature sensor.
b. When override button is pushed, the unit shall index to occupied mode for one (1) hour (adj.). After the override time has expired, the unit shall revert to unoccupied mode.

F. CONTROL POINTS:

Description	Type
Fan Amps/Status	AI
Compressor Amps/Status (Each Compressor)	AI
Mixed Air Temperature	AI
Supply Air Temperature	AI
Outside Air Temperature (Global)	AI

Description	Type
Space Temperature	AI
Bipolar Ionization Status	AI
Outside Air Damper Feedback	AI
Compressor Command (Each Stage)	DO
Reversing Valve	DO
Auxiliary Heat (Each Stage)	DO
Fan Start/Stop Command	DO
Outside Air Damper	AO

4.6 NON-CONDENSING PRIMARY/SECONDARY HEATING WATER SYSTEM

A. GENERAL:
1. There are two boilers pumps with circulating primary pumps and two building hot water pumps.

B. HEATING SYSTEM ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule.
2. The EMCS shall enable the hot water system based on an ambient temperature below 60° F (adj.) and requests for heating. The number of requests shall be adjustable. This system enable will enable each boiler and building pump. Equipment will operate on a lead-lag and equal run time basis.

C. HOT WATER PUMPING:
1. Building Pumping System:
a. One variable building pump will be started when system is enabled. If lead pump fails to start and flow not proven, system shall be able to auto rotate and start lag pump.
b. The pump VFD will be controlled by differential pressure transducer (s) across the supply and return piping at locations as shown on the drawings or as directed by the engineer. If the pressure is below setpoint, the pump speed will be increased. If the differential pressure is above setpoint, the pump speed will be decreased.
c. The lag pump will activate whenever the speed of the first pump is at or above 90% (adj.) for 15 minutes (adj.). The lag pump shall turn on and operate in unison with the lead pump to maintain building load. Once both pumps are operating at 40% (adj.), for 15 minutes (adj.) the lag pump shall turn off and the lead pump shall remain on to maintain building load.
d. The differential pressure setpoint for the pumping system shall be reset based on maximum hot water valve position. If the maximum valve position is above 90% (adj.), then the differential set point will be set to maximum pressure as determined by TAB contractor. If the maximum valve position is below 50% (adj.), then the differential pressure setpoint will be set to minimum pressure as determined by TAB contractor. If the maximum valve position is between 90%-50% (adj.), then the differential pressure setpoint will modulate linearly between the minimum and maximum pressure setpoints.

D. BOILER CONTROL:
1. Sequencing:
a. The EMCS will enable each boiler as needed to maintain building supply temperature. If lead boiler fails to start, system shall be able to auto rotate and start lag boiler.
2. Primary Circulating Pumps:
a. Primary circulating pumps shall be hardwired interlocked with boiler.

b. Primary circulating pumps shall run continuously anytime there is a call for its associated boiler.

3. Mixing Valve
   a. Each boiler is to have a 3-way mixing valve provided by boiler manufacturer.
   b. Mixing valve is to limit low water temperatures from entering boiler.

E. HOT WATER TEMPERATURE CONTROL:
1. The hot water setpoint will be sent by EMCS and will modulate boilers to meet setpoint.
2. There shall be a linear hot water supply temperature reset algorithm in between:
   a. 140°F (adj.) hot water supply when outside air temperature is at or above 60°F (adj.)
   b. 160°F (adj.) hot water supply when outside air temperature is at or below 45°F (adj.)

F. SAFETIES:
1. Freeze Protection:
   a. When the outside air (OA) temperature drops below 36°F (adj.), a building pump will be started. All building hot water valves will be open to 20%.
   b. When the OA temperature rises 2°F above freeze protection setpoint for one hour, the reverse shall occur.
2. CO Monitoring:
   a. A carbon monoxide sensor shall be installed in boiler room.
   b. Carbon monoxide sensor shall be hardwired interlocked with boiler(s) and shutdown boiler(s) when carbon monoxide rises above 50 ppm.
   c. Carbon monoxide alarm shall disable any supply fans in boiler room and enable all exhaust fans in boiler room.

G. CONTROL POINTS:

Description	Type
Outside Air Temperature	AI
Building Common Hot Water Supply Temperature	AI
Building Common Hot Water Return Temperature	AI
Boiler Supply Water Temperature (Each Boiler)	AI
Boiler Return Water Temperature (Each Boiler)	AI
Building Flow	AI
Makeup Water Flow	AI
Building Hot Water Differential Pressure (Each Sensor)	AI
Boiler Amps/Status (Each Boiler)	AI
Boiler Alarm (Each Boiler)	AI
Boiler Circulation Pump Amps/Status (Each Pump)	AI
Building Pump Amps/Status (Each Pump)	AI
CO Monitoring Alarm	DI
Boiler Enable (Each Boiler)	DO
Boiler Hot Water Setpoint (Each Boiler)	AO
Building Pump Start/Stop Command (Each Pump)	DO
Building Pump VFD Speed (Each Pump)	AO

4.7 OUTSIDE AIR HANDLING UNIT DX RTU

A. GENERAL:
1. The unit shall have supply fan, heating section, cooling coil and outside air damper. The control system contractor shall provide a dedicated stand-alone DDC controller for each unit.

B. UNIT ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS time schedule. **Unit shall not operate during optimum start/stop times or when associated units are in warm-up or cool-down mode.**

C. FAN CONTROL:
1. The outside air unit shall operate when the related units it serves are in occupied mode and operational. Outside air damper shall open and end switch shall prove damper is open. After an initial time, delay, the supply fan shall run.
2. Supply fan shall be disabled when outside air unit is unoccupied. Outside air damper shall also be closed when unit is unoccupied.

D. TEMPERATURE CONTROL:
1. Heating Section:
   a. The heating will modulate to maintain discharge air temperature of 55°F (adj.).
2. Cooling Coil:
   a. The cooling will modulate to initially maintain unit discharge supply air temperature of 55°F (adj.). In conjunction with reheat coil, suction pressure is to be used to maintain discharge supply temperature.
3. Reheat Coil:
   a. The reheat coils shall modulate to provide neutral supply air temperature set point (initially 72°F adj.). Reheat shall be accomplished through hot gas reheat.

E. CONTROL POINTS:

Description	Type
Fan Amps/Status	AI
Compressor Amps/Status (Each Compressor)	AI
Filter Alarm	DI
Entering Outside Air Temperature	AI
Entering Outside Air Humidity	AI
Heating Air Supply Temperature	AI
Unit Discharge Air temperature	AI
Outside Air Damper End Switch	DI
Suction Pressure	AI
Fan Start/Stop Command	DO
Fan VFD Speed	AO
Cooling Command (Each Stage)	DO
Cooling Capacity Control (Each Stage)	AO
Heating Command (Each Stage)	DO
Hot Gas Bypass	DO
Outside Air Damper	DO

4.8 SINGLE NON-CONDENSING PRIMARY/SECONDARY HEATING WATER SYSTEM

A. GENERAL:
1. There is a boiler with circulating primary pumps and building hot water pumps.

B. HEATING SYSTEM ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule.
2. The EMCS shall enable the hot water system based on an ambient temperature below 60° F (adj.) and requests for heating. The number of requests shall be adjustable. This system enable will enable each boiler and building pump. Equipment will operate on a lead-lag and equal run time basis.

C. HOT WATER PUMPING:
   1. Building Pumping System:
      a. One variable building pump will be started when system is enabled. If lead pump fails to start and flow not proven, system shall be able to auto rotate and start lag pump.
      b. The pump VFD will be controlled by differential pressure transducer (s) across the supply and return piping at locations as shown on the drawings or as directed by the engineer. If the pressure is below setpoint, the pump speed will be increased. If the differential pressure is above setpoint, the pump speed will be decreased.
      c. The lag pump will activate whenever the speed of the first pump is at or above 90% (adj.) for 15 minutes (adj.). The lag pump shall turn on and operate in unison with the lead pump to maintain building load. Once both pumps are operating at 40% (adj.), for 15 minutes (adj.) the lag pump shall turn off and the lead pump shall remain on to maintain building load.
      d. The differential pressure setpoint for the pumping system shall be reset based on maximum hot water valve position. If the maximum valve position is above 90% (adj.), then the differential set point will be set to maximum pressure as determined by TAB contractor. If the maximum valve position is below 50% (adj.), then the differential pressure setpoint will be set to minimum pressure as determined by TAB contractor. If the maximum valve position is between 90%-50% (adj.), then the differential pressure setpoint will modulate linearly between the minimum and maximum pressure setpoints.

D. BOILER CONTROL:
   1. Sequencing:
      a. The EMCS will enable boiler as needed to maintain building supply temperature.
   2. Primary Circulating Pumps:
      a. Primary circulating pumps shall be hardwired interlocked with boiler.
      b. Primary circulating pump shall run continuously anytime there is a call for its associated boiler.
   3. Mixing Valve
      a. Each boiler is to have a 3-way mixing valve provided by boiler manufacturer.
      b. Mixing valve is to limit low water temperatures from entering boiler.

E. HOT WATER TEMPERATURE CONTROL:
   1. The hot water setpoint will be sent by EMCS and will modulate boilers to meet setpoint.
   2. There shall be a linear hot water supply temperature reset algorithm in between:
      a. 140°F (adj.) hot water supply when outside air temperature is at or above 60°F (adj.)
      b. 160°F (adj.) hot water supply when outside air temperature is at or below 45°F (adj.)

F. SAFETIES:
   1. Freeze Protection:
      a. When the outside air (OA) temperature drops below 36°F (adj.), a building pump will be started. All building hot water valves will be open to 20%.
      b. When the OA temperature rises 2°F above freeze protection setpoint for one hour, the reverse shall occur.
   2. CO Monitoring:
      a. A carbon monoxide sensor shall be installed in boiler room.
      b. Carbon monoxide sensor shall be hardwired interlocked with boiler(s) and shutdown boiler(s) when carbon monoxide rises above 50 ppm.
      c. Carbon monoxide alarm shall disable any supply fans in boiler room and enable all exhaust fans in boiler room.

G. CONTROL POINTS:

Description	Type
Outside Air Temperature	AI
Building Common Hot Water Supply Temperature	AI
Building Common Hot Water Return Temperature	AI
Boiler Supply Water Temperature (Each Boiler)	AI
Boiler Return Water Temperature (Each Boiler)	AI
Building Flow	AI
Makeup Water Flow	AI
Building Hot Water Differential Pressure (Each Sensor)	AI
Boiler Amps/Status (Each Boiler)	AI
Boiler Alarm (Each Boiler)	AI
Boiler Circulation Pump Amps/Status (Each Pump)	AI
Building Pump Amps/Status (Each Pump)	AI
CO Monitoring Alarm	DI
Boiler Enable (Each Boiler)	DO
Boiler Hot Water Setpoint (Each Boiler)	AO
Building Pump Start/Stop Command (Each Pump)	DO
Building Pump VFD Speed (Each Pump)	AO

4.9 SINGLE CHILLER - VARIABLE PRIMARY CHILLED WATER SYSTEM

A. GENERAL:
1. There is a chiller with motorized isolation valves. The pumping system will be variable primary type with two pumps. The pump(s) will have a minimum flow condition equal to the minimum flow allowed by the chiller manufacturer. There will also be a bypass line with an automated control valve to allow the minimum flow of chillers. Minimum flow to be specified by the chiller manufacturer.

B. CENTRAL PLANT SYSTEM ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule.
2. The EMCS shall enable the chilled water system based on an ambient temperature above 50° F (adj.) and requests for cooling. The number of requests shall be adjustable. This system enable will assign the lead/lag chillers and lead/lag pumps. Equipment will operate on a lead-lag and equal run time basis.
3. The chillers slow stroking, motorized isolation valve (120 seconds) shall open.
4. After a time delay allowing the motorized isolation valve to fully open, the lead chilled water pump shall start. If lead pump fails to start and flow not proven, system shall be able to auto rotate and start lag pump.
5. Once a chilled water pump has started and water flow has been proven, the chiller shall be enabled. If lead chiller fails to start, system shall be able to auto rotate and start lag chiller.

C. CHILLED WATER TEMPERATURE CONTROL:
1. The chilled water setpoint will be controlled by EMCS by sending a setpoint signal 42°F (adj.) to each chiller control panel (UCP).
2. There shall be a linear chilled water supply temperature reset algorithm in between:
   a. 42°F (adj.) chilled water supply when outside air temperature is at or above 70°F (adj.)
   b. 46°F (adj.) chilled water supply when outside air temperature is at or below 50°F (adj.)

D. CHILLED WATER PUMPING SYSTEM:
   1. Variable Primary Chilled Pumping System:
      a. One variable primary pump will be started when system is enabled. If lead pump fails to start and flow not proven, system shall be able to auto rotate and start lag pump.
      b. The speed of the pumps shall not drop below minimum output to maintain minimum flow through enabled chillers.
      c. Anytime a there is a call for two chillers to run simultaneously, there shall be a call for two pumps to run simultaneously.
      d. The pump VFD will be controlled by differential pressure transducer (s) across the supply and return piping at locations as shown on the drawings or as directed by the engineer. If the pressure is below setpoint, the pump speed will be increased. If the differential pressure is above setpoint, the pump speed will be decreased.
      e. The lag pump will activate whenever the speed of the first pump is at or above 90% (adj.) for 15 minutes (adj.). The lag pump shall turn on and operate in unison with the lead pump to maintain building load. Once both pumps are operating at 40% (adj.), for 15 minutes (adj.) the lag pump shall turn off and the lead pump shall remain on to maintain building load.
      f. The differential pressure setpoint for the pumping system shall be reset based on maximum chilled water valve position. If the maximum valve position is above 90% (adj.), then the differential set point will be set to maximum pressure as determined by the temperature control system contractor. If the maximum valve position is below 50% (adj.), then the differential pressure setpoint will be set to minimum pressure as determined by the temperature control system contractor. If the maximum valve position is between 90%-50% (adj.), then the differential pressure setpoint will modulate linearly between the minimum and maximum pressure setpoints.

E. CHILLED WATER BYPASS:
   1. Minimum Flow:
      a. The chilled water bypass valve shall be initially closed and open as necessary to provide minimum flow to enabled chillers.
      b. Bypass valve shall monitor chiller flow meter to ensure minimum flow is being met by modulating bypass control valve open as necessary.
      c. As a failsafe backup to the flow meter, bypass valve shall also monitor the chilled water pressure drop across each chiller evaporator when a chiller is enabled. As the sensed differential pressure falls below the pressure drop associated with the chiller recommended flow rate, as provided by the chiller manufacturer, modulate the bypass control valve to maintain minimum flow. Initial default chiller evaporator pressure drop of 3 psi (adj.).

F. SAFETIES:
   1. Freeze Protection:
      a. When the outside air (OA) temperature drops below 36°F (adj.), a primary pump will be started and all associated isolation valves opened. All building chilled water valves will be open to 20%.
      b. When the OA temperature rises 2°F above freeze protection setpoint for one hour, the reverse shall occur.

G. Control Points:

Description	Type
Outside Air Temperature	AI
Building Common Chilled Water Supply Temperature	AI
Building Common Chilled Water Return Temperature	AI
Chiller Supply Water Temperature (Each Chiller)	AI

Description	Type
Chiller Return Water Temperature (Each Chiller)	AI
Chilled Water Bypass Temperature	AI
Chiller Evaporator Differential Pressure (Each Chiller)	AI
Building Flow	AI
Chiller Flow	AI
Makeup Water Flow	AI
Building Chilled Water Differential Pressure (Each Sensor)	AI
Chiller Amps/Status (Each Chiller)	AI
Chiller Alarm (Each Chiller)	AI
Pump Amps/Status (Each Pump)	AI
Motorized Valve Feedback Position (Each Valve)	AI
Chiller Start/Stop Command (Each Chiller)	DO
Pump Start/Stop Command (Each Pump)	DO
Pump VFD Speed (Each Pump)	AO
Chiller Supply Setpoint (Each Chiller)	AO
Chiller Capacity Limit (Each Chiller)	AO
Chiller Isolation Valve (Each Chiller)	AO
Chilled Water Bypass Valve	AO

4.10 SPLIT SYSTEM UNIT - DX AND HEAT AND IONIZER

A. GENERAL:
1. The split system unit shall be provided with a filter, supply fan, cooling coil, heat and outside air damper. The control system contractor shall provide a dedicated stand-alone DDC controller for each unit.

B. UNIT ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule.
2. During unoccupied times, as required to maintain the unoccupied heating and cooling setpoints 55°F (adj.) heating and 85°F (adj.) cooling as sensed by the space temperature sensor.
3. When the override pushbutton is depressed, the unit shall be indexed to the occupied mode for an adjustable period of time (initially 1 hour). After the override time period has expired, the unit shall revert back to the unoccupied mode.

C. FAN CONTROL:
1. Fan speed shall be controlled by the unit's internal controls.

D. OUTSIDE AIR DAMPER CONTROL:
1. Warm-up or Cool-down:
   a. The outside air damper shall be closed.
2. Occupied Mode:
   a. The outside air damper shall be at the minimum position (adj.) as set by TAB
3. Unoccupied Mode:
   a. The outside air damper shall be closed.

E. TEMPERATURE CONTROL:
1. Warm-up or Cool-down:
   a. The EMCS shall determine the required warm-up or cool-down period based on the optimized start algorithm.

b. Upon enabling the unit, the unit shall heat and cool as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor.
c. Once the occupied setpoint temperature has been reached, the EMCS shall switch the unit to the occupied mode.

2. Occupied Mode:
   a. Space set point shall be user adjustable within ±2°F (adj.).
   b. In the occupied mode of operation, the unit supply fan shall cycle with a call for heating or cooling.
   c. The unit shall heat and cool as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor.
   d. When space temperature rises above occupied cooling setpoint, the DDC controller shall energize the first stage of mechanical cooling. First stage cooling shall have a 20-minute (adj.) runtime before allowing second stage to engage. When space temperature continues to rise 2°F (adj.) above occupied cooling setpoint, the DDC controller shall energize the second stage of mechanical cooling.
      (1) First stage cooling – Low speed supply CFM and first stage of compressor(s).
      (2) Second stage cooling – High speed supply CFM and second stage of compressor(s).
         - Unit shall run in second stage cooling until space temperature drops to occupied space cooling setpoint. Unit shall then run in first stage of cooling until space temperature drops 1°F (adj.) below space temperature setpoint and then cycle off.
   e. When space temperature drops below occupied heating setpoint, the DDC controller shall energize the first stage of heat. When space temperature continues to drop 2°F (adj.) below occupied heat setpoint, the DDC controller shall energize the second stage of heat.
      (1) First stage heating – Low speed supply CFM and first stage of heat.
      (2) Second stage heating – High speed supply CFM and second stage of heating.
         - Unit shall run in second stage heating until space temperature rises to occupied space heating setpoint. Unit shall then run in first stage heating until space temperature rises 1°F (adj.) above space temperature setpoint and then cycle off.

3. Unoccupied Mode:
   a. The EMCS shall enable the unit as required to maintain the unoccupied heating and cooling setpoints (initially 55°F heating and 85°F cooling) as sensed by the space temperature sensor.
   b. When override button is pushed, the unit shall index to occupied mode for one (1) hour (adj.). After the override time has expired, the unit shall revert to unoccupied mode.

F. CONTROL POINTS:

Description	Type
Fan Amps/Status	AI
Compressor Amps/Status (Each Compressor)	AI
Mixed Air Temperature	AI
Supply Air Temperature	AI
Outside Air Temperature (Global)	AI
Space Temperature	AI
Bipolar Ionization Status	AI
Outside Air Damper Feedback	AI
Cooling Command (Each Stage)	DO
Heating Command (Each Stage)	DO

Description	Type
Fan Start/Stop Command	DO
Outside Air Damper	AO

4.11 SINGLE ZONE VARIABLE AIR VOLUME AIR HANDLING UNIT (CHILLED WATER/ HOT WATER HEAT)

A. GENERAL:
1. The unit shall have supply fan, hot water coil, chilled water coil and outside air damper. The control system contractor shall provide a dedicated stand-alone DDC controller for each unit.

B. UNIT ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule.
2. During unoccupied times, as required to maintain the unoccupied heating and cooling setpoints 55°F (adj.) heating and 85°F (adj.) cooling as sensed by the space temperature sensor.
3. When the override pushbutton is depressed, the unit shall be indexed to the occupied mode for an adjustable period of time (initially 1 hour). After the override time period has expired, the unit shall revert back to the unoccupied mode.

C. FAN CONTROL:
1. During cooling mode, the unit supply air fan shall run continuously, the VFD shall modulate the supply air fan to maintain space setpoint, and the chilled water valve shall modulate to maintain cooling supply air temperature setpoint. Minimum fan speed shall be set at 20Hz (adj.).
2. During heating mode, the unit supply air fan shall run continuously, the VFD shall modulate the supply air fan to maintain space setpoint, and the hot water valve shall modulate to maintain space temperature setpoint. Minimum fan speed shall be set at 35Hz (adj.).

D. TEMPERATURE CONTROL:
1. Warm-up or Cool-down:
   a. The EMCS shall determine the required warm-up or cool-down period based on the optimized start algorithm.
   b. Upon enabling the unit, the unit shall heat and cool as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor.
   c. During warm-up, the supply air discharge temperature shall be 90°F (adj.). During cool-down, the supply air temperature shall be 53°F (adj.).
   d. Once the occupied setpoint temperature threshold has been reached, the EMCS shall switch the unit to the occupied mode.
2. Occupied Mode:
   a. Space set point shall be user adjustable within ±2°F (adj.).
   b. Heating Mode:
      (1) When space temperature is below heating setpoint, the unit is in heating mode. The reheat valve will modulate to maintain space temperature and discharge temperature of no more than 90°F (adj.).
   c. Cooling Mode:
      (1) When space temperature is above cooling setpoint, the unit is in cooling mode. The chilled water valve will modulate to maintain a scheduled cooling supply air setpoint at all times during cooling mode. Initially unit discharge supply air temperature of 53°F (adj.). There shall be a linear supply air temperature reset algorithm in between:

- 53°F (adj.) supply air temperature supply when outside air temperature is at or above 80°F (adj.)
- 58°F (adj.) supply air temperature supply when outside air temperature is at or above 50°F (adj.)

3. Unoccupied Mode:
   a. The EMCS shall enable the unit as required to maintain the unoccupied heating and cooling setpoints (initially 55°F heating and 85°F cooling) as sensed by the space temperature sensor.
   b. If/Whenever the override pushbutton is depressed, the unit shall be indexed to the occupied mode for an adjustable period of time (initially 1 hour). After the override time period has expired, the unit shall revert back to the unoccupied mode.

E. OUTSIDE AIR DAMPER CONTROL:
1. Warm-up or Cool-down:
   a. The outside air damper shall be closed.
2. Occupied Mode:
   a. The outside air damper shall be at the minimum position (adj.) as set by TAB
3. Unoccupied mode:
   a. The outside air damper shall be closed.

F. DRY BULB ECONOMIZER MODE:
1. In occupied or unoccupied mode, when space temperature is above space setpoint, outside air temperature is 60°F (adj.) or below and there is a call for cooling, the unit shall be in economizer mode. Outside air damper is to open 100% and to provide free cooling to the space until the space temperature setpoint is satisfied. If space is not satisfied within 10 min (adj.), mechanical cooling will be enabled.

G. DEHUMIDIFICATION MODE:
1. Dehumidification mode shall be activated when space temperature is satisfied, and the space relative humidity is above 60% (adj.).
2. Dehumidification mode shall temporarily disable the cooling supply air temperature reset and maintain cooling coil to a constant discharge air temperature at 53°F (adj.). Reheat valve shall modulate to maintain neutral discharge air temperature to prevent overcooling.
3. Dehumidification shall disable when return air relative humidity is 2% (adj.) below humidity setpoint.

H. SAFETIES:
1. Freeze Protection:
   a. When the outside air (OA) temperature drops below 36°F (adj.), chilled water and hot water valves will be open to 20% if not already open.
   b. When the OA temperature rises 2°F above freeze protection setpoint for one hour, the reverse shall occur.
2. Freeze Stat:
   a. A temperature low limit switch shall be provided to disable the unit and close all dampers when it senses that the air temperature is below 36°F (adj.)

I. CONTROL POINTS:

Description	Type
Fan Amps/Status	AI
Filter Alarm	DI
Space Temperature	AI
Mixed Air Temperature	AI
Return Air Temperature	AI
Space Humidity	AI

Description	Type
Space CO2	AI
Cooling Supply Air Temperature (PreHeat)	AI
Unit Discharge Air temperature (ReHeat)	AI
Freeze Status Alarm	DI
Bipolar Ionization Status (If Scheduled/Equipped)	DI
Fan Start/Stop Command	DO
Fan VFD Speed	AO
Chilled Water Valve	AO
Hot Water Valve	AO
Outside Air Damper	AO

4.12 MULTIPLE CHILLERS - VARIABLE PRIMARY CHILLED WATER SYSTEM

A. GENERAL:
1. There are two chillers with motorized isolation valves. The pumping system will be variable primary type with two pumps. The pump(s) will have a minimum flow condition equal to the minimum flow allowed by the chiller manufacturer. There will also be a bypass line with an automated control valve to allow the minimum flow of chillers. Minimum flow to be specified by the chiller manufacturer.

B. CENTRAL PLANT SYSTEM ENABLING/DISABLING:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule.
2. The EMCS shall enable the chilled water system based on an ambient temperature above 50° F (adj.) and requests for cooling. The number of requests shall be adjustable. This system enable will assign the lead/lag chillers and lead/lag pumps. Equipment will operate on a lead-lag and equal run time basis.
3. The lead chillers slow stroking, motorized isolation valve (120 seconds) shall open.
4. After a time delay allowing the motorized isolation valve to fully open, the lead chilled water pump shall start. If lead pump fails to start and flow not proven, system shall be able to auto rotate and start lag pump.
5. Once a chilled water pump has started and water flow has been proven, the lead chiller shall be enabled. If lead chiller fails to start, system shall be able to auto rotate and start lag chiller. The motorized isolation valve shall be opened/closed with the enabling/disabling of its corresponding chiller.
6. Upon each start of the chilled water system, it will activate a lag chiller enable delay of 1 hour (adj.) in order for the system loop and the lead chiller to stabilize.

C. CHILLED WATER TEMPERATURE CONTROL:
1. The chilled water setpoint will be controlled by EMCS by sending a setpoint signal 42°F (adj.) to each chiller control panel (UCP).
2. There shall be a linear chilled water supply temperature reset algorithm in between:
   a. 42°F (adj.) chilled water supply when outside air temperature is at or above 70°F (adj.)
   b. 46°F (adj.) chilled water supply when outside air temperature is at or below 50°F (adj.)

D. CHILLER DEMAND LIMIT:
1. Chiller demand limiting will be used at least 120 seconds (adj.) prior to the sequencing and staging up of lag chillers.
2. The chiller demand limit signal of 40% (adj.) will be sent by EMCS to chillers.
3. Once the staging up of lag chiller has occurred, the chiller limit signal shall stay active for an additional 300 seconds (adj.) to allow system to stabilize. After time delay is over, the chiller demand limiting signal shall be disabled

E. STAGING OF CHILLER:
1. Staging Up (The lag chiller shall be enabled when any of the following conditions occur):
   a. When the chilled water supply temperature exceeds the set point by 2°F (adj.) and a 5°F differential from return water temperature for a 15 minute period (adj.). the EMCS will enable the second chiller. The bypass automatic control valve shall be reset to allow total minimum GPM of both chillers to flow through the bypass.
   b. When lead chiller load is at 85% (adj.) or more for 15 minutes (adj.).
   c. When lead chiller fails or is in alarm.
2. Staging Down (The lag chiller shall be disabled when any of the following conditions occur):
   a. When the chilled water supply temperature is at or below the set point and there is at least a 6°F differential from return water temperature for a 15 minute period (adj.). the EMCS will disable the second chiller. The bypass automatic control valve shall be reset to allow total minimum GPM of one chiller to bypass.
   b. When chiller loads are at 40% (adj.) or less for 15 minutes (adj.).

F. CHILLED WATER PUMPING SYSTEM:
1. Variable Primary Chilled Pumping System:
   a. One variable primary pump will be started when system is enabled. If lead pump fails to start and flow not proven, system shall be able to auto rotate and start lag pump.
   b. The speed of the pumps shall not drop below minimum output to maintain minimum flow through enabled chillers.
   c. Anytime a there is a call for two chillers to run simultaneously, there shall be a call for two pumps to run simultaneously.
   d. The pump VFD will be controlled by differential pressure transducer (s) across the supply and return piping at locations as shown on the drawings or as directed by the engineer. If the pressure is below setpoint, the pump speed will be increased. If the differential pressure is above setpoint, the pump speed will be decreased.
   e. The lag pump will activate whenever the speed of the first pump is at or above 90% (adj.) for 15 minutes (adj.). The lag pump shall turn on and operate in unison with the lead pump to maintain building load. Once both pumps are operating at 40% (adj.), for 15 minutes (adj.) the lag pump shall turn off and the lead pump shall remain on to maintain building load.
   f. The differential pressure setpoint for the pumping system shall be reset based on maximum chilled water valve position. If the maximum valve position is above 90% (adj.), then the differential set point will be set to maximum pressure as determined by the temperature control system contractor. If the maximum valve position is below 50% (adj.), then the differential pressure setpoint will be set to minimum pressure as determined by the temperature control system contractor. If the maximum valve position is between 90%-50% (adj.), then the differential pressure setpoint will modulate linearly between the minimum and maximum pressure setpoints.

G. CHILLED WATER BYPASS:
1. Minimum Flow:
   a. The chilled water bypass valve shall be initially closed and open as necessary to provide minimum flow to enabled chillers.
   b. Bypass valve shall monitor chiller flow meter to ensure minimum flow is being met by modulating bypass control valve open as necessary.
   c. As a failsafe backup to the flow meter, bypass valve shall also monitor the chilled water pressure drop across each chiller evaporator when a chiller is enabled. As the sensed differential pressure falls below the pressure drop associated with the chiller recommended flow rate, as provided by the chiller manufacturer, modulate the bypass control valve to maintain minimum flow. Initial default chiller evaporator pressure drop of 3 psi (adj.).

H. SAFETIES:
1. Freeze Protection:
a. When the outside air (OA) temperature drops below 36°F (adj.), a primary pump will be started and all associated isolation valves opened. All building chilled water valves will be open to 20%.
b. When the OA temperature rises 2°F above freeze protection setpoint for one hour, the reverse shall occur.

I. Control Points:

Description	Type
Outside Air Temperature	AI
Building Common Chilled Water Supply Temperature	AI
Building Common Chilled Water Return Temperature	AI
Chiller Supply Water Temperature (Each Chiller)	AI
Chiller Return Water Temperature (Each Chiller)	AI
Chilled Water Bypass Temperature	AI
Chiller Evaporator Differential Pressure (Each Chiller)	AI
Building Flow	AI
Chiller Flow	AI
Makeup Water Flow	AI
Building Chilled Water Differential Pressure (Each Sensor)	AI
Chiller Amps/Status (Each Chiller)	AI
Chiller Alarm (Each Chiller)	AI
Pump Amps/Status (Each Pump)	AI
Motorized Valve Feedback Position (Each Valve)	AI
Chiller Start/Stop Command (Each Chiller)	DO
Pump Start/Stop Command (Each Pump)	DO
Pump VFD Speed (Each Pump)	AO
Chiller Supply Setpoint (Each Chiller)	AO
Chiller Capacity Limit (Each Chiller)	AO
Chiller Isolation Valve (Each Chiller)	AO
Chilled Water Bypass Valve	AO

WATER SOURCE HEAT PUMP CENTRAL PLANT AND LOOP CONTROL

A. GENERAL:
1. The system panel shall provide centralized control of the pumps, boilers, and closed loop cooling towers, and coordinate the application specific controllers located on each water-source heat pump.

B. Central Plant Enabling/Disabling:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule. **The central plant shall start before any of the water source heat pumps start. No water source unit shall enable without the central plant already being on. The water source heat pumps shall be disabled when loop temp is below 55°F and greater than 105°F.**

C. Condenser Pumping:
1. There will be two building pumps each controlled by a VFD that will operate on a lead-lag and equal run time basis. One building pump will be started when the central plant is enabled. The pump VFD will be controlled by a differential pressure across the supply and return piping at locations as shown on the drawings or as directed by the engineer. If the pressure is below setpoint, the pump speed will be increased. If the differential pressure is above setpoint, the pump speed will be decreased.
2. The second pump will activate whenever the second/lag fluid cooler is enabled. The lag pump shall turn on and operate in unison with the lead pump to maintain building load.

D. TEMPERATURE CONTROL:
1. Occupied Mode: Once the condenser pumps have proven flow and a time delay of 5 minutes (adj.) has passed, the loop temperature control sequence shall enable and control to the following:

Loop Temperature Below 60°F

Device Description	Control Action
Fluid Coolers	Disabled
Fluid Cooler Isolation Valves	Closed
Fluid Cooler 3-Way Bypass	Bypass Fluid Coolers
Boilers	Enabled

Loop Temperature Between 60°F- 85°F

Device Description	Control Action
Fluid Coolers	Disabled
Fluid Cooler Isolation Valves	Closed
Fluid Cooler 3-Way Bypass	Open to Fluid Coolers
Boilers	Disabled

Loop Temperature Above 85°F

Device Description	Control Action
Fluid Coolers	Enabled, Lead/Lag
Fluid Cooler Isolation Valves	Open with associated unit
Fluid Cooler 3-Way Bypass	Open to Fluid Coolers
Boilers	Disabled

Unoccupied Mode: When the loop goes into unoccupied mode, the compressors on the units will be disabled and the units will control to their unoccupied setpoints.

E. Fluid Cooler Control:
1. There will be two fluid cooler fans each controlled by a VFD that will operate on a lead-lag and equal run time basis. One fluid cooler fan will be started when the central plant is enabled, and loop temperature is above 85°F (adj.).
2. The lag fluid cooler will activate whenever the lead fluid cooler is enabled for 30 mins (adj.) and cannot maintain loop temperature of 85°F (adj.). Lag fluid cooler will immediately enable if loop temp is above 85°F (adj.). The lag fluid cooler shall turn on and operate in unison with the lead fluid cooler to maintain building load.
3. Associated fluid cooler circulating pump shall be interlocked with its fan.
4. Motorized 3-way diverting valve shall be open to tower when operating.

F. Boiler Control:
1. There will be two boilers each with their own primary pumps. Primary pumps to be interlocked and controlled by boiler. EMCS shall enable boiler sequencing panel and boilers shall operate and stage according to sequencer to maintain loop temperature of 60°F (adj.).

G. Freeze Protection:
1. When the outside air temperature falls below 36°F (adj.), unit isolation valves shall open, the 3-way bypass valve shall open to the tower and one of the building condenser pumps shall run continuously. When outside air temperature rises 2°F above freeze protection setpoint for one hour the system will disable freeze protection.

H. Control Points:

Description	Type
Outside Air Temperature	AI
Fan Amps/Status (Each Fan)	AI
CW Pump Amp/Status (Each Pump)	AI
Building CW Supply Temperature	AI
Building CW Return Temperature	AI
Building CW Differential Pressure	AI
Water Temperature Between Fluid Coolers and Boilers	AI
Building Flow	AI
Makeup Water Flow	AI
Motorized Valve Feedback Position (Each Valve)	AI
Fan Start/Stop Command (Each Fan)	DO
Fan VFD Speed (Each Fan)	AO
CW Pump Start/Stop Command (Each Pump)	DO
Pump VFD Speed (Each Pump)	AO
Motorized Isolation Valve (Each Valve)	AO
3-Way Diverting Valve	AO
Boiler Sequencer System Enable	DO
Boiler Supply Water Temperature (Each Boiler)	AO
Boiler Return Water Temperature (Each Boiler)	AO
Boiler Circulation Pump Amps/Status (Each Pump)	AI
Boiler Alarm (Each Boiler)	DI

WATER SOURCE HEAT PUMP UNIT

A. GENERAL:
1. Each system shall consist of an indoor heat pump unit. The heat pump shall be provided with a filter, coil section, compressor, supply fan, motorized isolation water valve and reversing valve. The control system contractor shall provide a dedicated stand-alone DDC controller for each unit.

B. Unit Enabling/Disabling:
1. The occupied/unoccupied mode of operation shall be defined by the EMCS optimum start/stop schedule. The motorized isolation valve shall be opened/closed with the enabling/disabling of the unit. **The central plant shall start before any of the water source heat pumps start. No water source unit shall enable without the central plant already being on. The water source heat pumps shall be disabled when loop temp is below 50°F and greater than 105°F.**

C. TEMPERATURE CONTROL:
1. Warm-up or Cool-down: The EMCS shall determine the required warm-up or cool-down period based on the optimized start algorithm. Upon enabling the unit, the unit shall energize the heating and cooling as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor. Once the occupied heating setpoint temperature of has been reached, the EMCS shall switch the unit to the occupied mode.
2. Occupied Mode: In the occupied mode of operation, the unit supply fan, compressor, reversing valve and isolation valve shall cycle with a call for heating or cooling. The unit shall energize the heating and cooling as required to maintain the occupied heating and cooling setpoints (initially 70°F heating, 74°F cooling) as sensed by a space temperature sensor with digital display and override pushbutton. Space setpoint shall be user adjustable within ±2°F (adjustable).
3. Unoccupied Mode: The unit shall enable the compressor, supply fan and reversing valve as required to maintain the unoccupied heating and cooling setpoints (initially 55°F heating and 85°F cooling) as sensed by the space temperature sensor.

D. Control Points:

Description	Type
Fan Amps/Status	AI
Suction Temperature	AI
Supply Air Temperature	AI
Space Temperature	AI
Pump Status	DI
Alarm Status	DI
Fan Start/Stop Command	DO
Compressor Start/Stop Command (Each Compressor)	DO
Compressor Capacity Control (Only Units with Digital Scroll)	AO
Head Pressure Valve (Only Units with Digital Scroll)	AO
Reversing Valve Command	DO
Motorized Isolation Valve	DO

END OF SECTION

SECTION 23 09 25

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Variable Frequency Drive (VFD) and options including bypasses.

1.3 SCOPE OF WORK

A. This section provides specification for AC variable frequency drives or herein identified as VFD's for use with {NEMA B, NEMA D, NEMA A, NEMA E, Wound Rotor} design AC motors.

B. The VFD manufacturer shall furnish, test, adjust and certify all packages systems for satisfactory operation prior to shipment.

C. Any exceptions / deviations to this specification shall be indicated in writing and submitted.

1.4 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 09 23 - Energy Management Control System

C. Section 23 21 23 - Hydronic Pumps

D. Section 23 73 13 - Modular Indoor Central Station Air Handling Units

1.5 REFERENCES

A. EN 61010-1 - Safety requirement for electrical equipment for measurement, control, and laboratory use. Part 1 - General Requirement.

B. EN 60204-1 - Safety of machinery-electrical equipment of machines. Part 1 - Specification for general requirement.

C. EN 60950 - Safety of information technology equipment including electrical business equipment.

D. IEC 664 - Insulation coordination for equipment within low-voltage systems.

E. IEC 60068-2-6 - Environmental testing - Part 2 - Test Fc: vibration (sinusoidal).

F. IEC 60068-2-27 - Environmental testing. Part 2: Tests. Test Ea and guidance: Shock

G. IEC 801-4 - Electrical Fast Transient (Supplementary Wave).

H. IEEE 519-2014 - Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

I. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

J. NEC - National Electrical Code

K. NEMA ICS6 - Industrial control and systems enclosures.

L. NEMA 250 - Enclosures for electrical equipment.

M. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

N. NEMA FU1 - Low Voltage Cartridge Fuses.

O. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives.

P. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.

Q. UL 508 - Industrial control equipment.

R. UL 61800-5-1

S. UL Type 1 or Type 12 - As listed in the contract documents.

1.6 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 1.

B. Product Data:
   1. Provide as outlined in the contract documents previously issued:
      a. General description, voltage, horsepower, max current ratings, diagrams.
      b. Ratings and weights.

C. Shop Drawings:
   1. Provide as outlined in the contract documents previously issued:
      a. Outline dimensions.
      b. Mounting points.
      c. Interconnecting wiring diagrams.

D. Manufacturer's Installation Instructions:
   1. Provide with each variable frequency drive at time of shipment and submittal:
      a. Installation methods
      b. Connection points

E. Submit product data for Variable Frequency Drive (VFD) with submittal package. Include manufacturer, dimensions, ratings, listings, elementary power and control wiring diagrams and data on features and components. Provide mounting points and connection points. Any exceptions to the specification shall be clearly noted in the submittal.

1.7 QUALITY ASSURANCE

A. The VFD and options shall comply with the applicable requirements of the latest standards of ANSI, IEEE, and the National Electrical Code.

B. The VFD and options shall be tested to ANSI/UL Standard 508 and listed by a nationally recognized testing agency such as UL or ETL. Device shall bear label.

C. To ensure quality and minimize infantile failures at the jobsite, the VFD shall be “burned in” for 24-hours by the manufacturer.

D. All VFD shall be UL listed for short circuit current rating of 65 kA and UL label shall be attached accordingly.

E. All VFD system door mounted pilot devices shall be tested to verify successful operation. Documentation shall be provided upon the request of the engineer.

F. All features shall be functionally tested at the factory for proper operation.

1.8 WARRANTY

A. VFD shall be free from defects in materials and workmanship under normal use and service for a period of twenty-four (24) months from shipment.

PART 2 PRODUCTS

2.1 GENERAL

A. Manufacturers:
   1. ABB
   2. Danfoss

B. Furnish complete variable speed drives as specified herein. All standard and optional features requested shall be included within the VFD enclosure unless otherwise specified. Drives shall be for variable torque load, unless otherwise noted.

C. The variable speed drives shall convert three-phase, 60 HZ utility power to adjustable voltage and frequency, three-phase, AC power for step less motor speed control from 10% to 100% of the motor's 60 Hz speed. Input voltage shall be as specified on the schedule.

D. The VFD power input stage shall convert three-phase AC line power to a fixed DC bus voltage. This will be accomplished with a solid state three-phase full-wave diode rectifier with metal oxide varistor (MOV) three-phase protection. Displacement power factor shall not be less than 0.95 throughout the speed range. Input line inductors (3%) shall be included on the line side of the power input state for units that have saturating (non-linear) DC link reactors.

E. The VFD output power shall vary frequency to the motor from 6 to 60 Hz with resultant motor speed varying at the motor nameplate rated speed, with output voltage variation from zero to motor rated voltage for optimum volts per hertz (V/Hz) ratio for fan and pump loads. Output current shall be rated 110% of motor full load amps (FLA) for 1 minute based upon VFD's variable torque FLA rating. The output must be a voltage source type generating a sine coded PWM waveform utilizing an asynchronous carrier frequency (output transistor switching frequency is to be independent of drive output frequency). This carrier frequency shall be adjustable to minimize harmonically induced noise or vibration.

F. All VFD shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.

G. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

2.2 FEATURES

A. The VFD shall include the following features:
   1. The VFD shall be housed in a NEMA 1 enclosure for indoor applications.
   2. The VFD shall be housed in a NEMA 3R enclosure for outdoor applications.
   3. The following display/control parameters shall be located on the front of the enclosure:
      a. Hand/Off/Auto selector to start and stop the motor. In the auto position, the drive shall start/stop from a remote contact closure. In the auto position, motor speed shall be determined by the follower signal. In the manual position, motor speed shall be determined by manual adjustment.
      b. Power on indication that the VFD is being supplied by the power line.
      c. Fault indication that the VFD has tripped on a fault condition.
      d. Display shall indicate load parameters such as load percent, frequency or running load amps.
      e. A set of form C, dry contacts to indicate when the VFD is in the run mode.
      f. A set of form C, dry contacts to indicate when the VFD is in the fault mode.
      g. Terminations for safety interlocks such as freeze and smoke shut-down.
      h. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function shall provide up to 6 programmable restart attempts. The time delay before restart attempts shall be a minimum of 30 seconds. This function permits automatic restarting after the drive controller detects a fault, provided that the other operating functions are correct, a run command is present, and the fault has disappeared. This shall be a function that is field selectable.
      i. The VFD shall include a door interlocked, padlockable, input power disconnect switch.

B. The following bypass features shall be included:
   1. Manual bypass shall provide all the circuitry necessary to transfer the motor from the VFD to the power line, or from the line to the controller.
   2. The AC Drive shall include mechanically and electrically interlocked isolation and bypass contactors, and AC line isolation contactor, complete with thermal overload relay, VFD/OFF/BYPASS switch and TEST/NORMAL selector switch.
   3. Motor overload protection shall be provided in both the controller mode and the bypass mode.
   4. The operator shall have full control of the bypass starter by operation of the VFD/OFF/BYPASS selector switch.
   5. In the automatic mode of operation, the isolation and bypass contactors shall be sequenced by the 110 volt rated auto start contact provided by user.
   6. A test/normal selector switch shall provide test operation of the power converter while operating the motor in bypass.
   7. A pilot light shall indicate whether motor is operating in drive or bypass mode.

C. Speed Reference Input:
   1. Shall accept both a manual speed signal and a 0-10 VDC speed reference analog input signal from the Building Automation System (BAS). The input signal will generally be a temperature signal on single zone VAV applications or cooling tower control or a pressure signal on VAV applications.

D. Feedback Signal:
   1. Provide 0-5 VDC or 0-20 mA analog output signal to indicate actual operating speed of VFD. Output signal shall be fed into the BAS.

E. The VFD shall include a standard communications port and capabilities to be connected to the following serial communications protocols at no additional cost and without the need to install any additional hardware or software in the VFD.
   1. RS-485 for Modbus, N2, FLN, P1, and BACnet.
   2. Ethernet for Modbus/ TCPIP and BACnet/ IP.
   3. Lonwork FTP shall be available as an option for factory or field installation.

2.3 PROTECTIVE FEATURES

A. The VFD shall include the following protective features:
   1. Protection against input transient voltage spikes.
   2. Minimum 65,000 A short circuit current rating for the VFD and enclosure
   3. Separate overload protection for each motor controlled.
   4. Protection against input power under voltage, over voltage, and phase loss.
   5. Protection against output current overload and over current.
   6. Protection against over temperature within the VFD enclosure.
   7. Protection against over voltage on the DC bus.
   8. DC bus discharge circuit for protection of service personnel.
   9. Insensitive to incoming power phase sequence.
   10. The number of restart attempts shall be adjustable from 0 to 20 and the time between attempts shall be adjustable between zero and 600 seconds. The original set-up shall be 4 restarts with 120 seconds between restarts.
   11. Four programmable critical frequency lockouts ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment.
   12. An automatic start delay may be selected from 0 to 120 seconds. During the start delay the VFD shall be programmed to provide either no voltage to the motor or apply DC braking current if desired.

2.4 ADJUSTMENTS

A. The VFD shall include the following adjustments inside the enclosure:
   1. Maximum speed, adjustable 50-100% base speed.
   2. Minimum speed, adjustable 0-50% base speed.
   3. Acceleration time, adjustable 3 to 1800 seconds.
   4. Deceleration time, adjustable 3 to 1800 seconds with override circuit to prevent nuisance trips if deceleration time is set too short.
   5. Current limit, adjustable 0-100%.

2.5 SERVICE CONDITIONS

A. The VFD shall be designed to operate within the following service conditions:
   1. Ambient temperature, 14°F to 113°F.
   2. 0 to 95% relative humidity, non-condensing.
   3. Elevation to 3,300 feet without derating.
   4. AC line voltage variation, -10% to +10% of nominal.
   5. No side clearance shall be required for cooling.
   6. All VFD shall be plenum rated.

PART 3 EXECUTION

3.1 INSTALLATION AND START UP SERVICE

A. Variable frequency drives shall be provided by the mechanical contractor, installed by the electrical contractor, and controlled by the controls contractor.

B. The manufacturer shall provide start up service by a factory trained service technician. The service technician shall verify correct installation, start up the drive, and check for proper operation.

C. The VFD's shall be mounted and installed in accordance with all local, state, federal and NEC codes.

D. Before and during the installation, the VFD shall be protected from site and environmental contaminants. VFD's shall be stored as necessary in a clean and dry location.

E. Installation shall be in compliance with the manufacturer's instructions, drawings and recommendations.

F. Start-up Assistance:
   1. On-site assistance shall be available from a factory certified technical representative who shall supervise the contractor's installation, testing and start-up of the VFD.
   2. The start-up assistance shall be quoted as a separate line item.

G. Do not install VFD until building environment can be maintained in accordance with manufacturer's instructions and requirements.

3.2 TRAINING

A. The manufacturer shall have regularly scheduled maintenance and training schools for the equipment supplied and installed.

B. Training course shall be quoted as a separate line item with submittal.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING, VALVES, AND APPURTENANCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Hot and Chilled water piping

B. Condenser water piping

C. Chilled, hot, and condenser water valves

D. Piping accessories and equipment

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 19 - Meters and Gauges for HVAC Piping

C. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

D. Section 23 07 19 - Hydronic Piping Insulation

E. Section 23 09 23 - Energy Management Control System

F. Section 23 21 23 - Hydronic Pumps

G. Section 23 33 33 - Access Doors

H. Section 23 52 33 - Water Tube Boilers

I. Section 23 64 23 - Air-Cooled Scroll Compressor Chillers

1.4 REFERENCES

A. ASTM - American Society of Testing and Materials

B. ASTM B-62-02 - Standard Specification for Composition Bronze or Ounce Metal Casting

C. ASTM A126 (2014) - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

D. ASTM A536-84 (2014) e1 - Standard Specification for Ductile Iron Castings

E. ASTM B148-97 e1 - Standard Specification for Aluminum-Bronze Sand Castings

F. ASTM B584-11 - Standard Specifications for Copper Alloy Sand Castings for General Applications

G. ASTM A844-09/A844M-09 - Standard Specification for Steel Plates, 9% Nickel Alloy, for Pressure Vessels, Produced by the Direct Quenching Process

1.5 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 00, General Conditions, and Division 1.

B. Submit product data on all piping materials, valves, piping accessories and equipment.

1.6 QUALITY ASSURANCE

A. All welders are to have certification. Furnish welder's certification prior to performing work.

PART 2 PRODUCTS

2.1 PIPING MATERIAL

A. Chilled and Hot Water Piping:
   1. ½" through 2" - Type L hard drawn copper
   2. 2½" and larger - Standard black steel pipe

B. All piping to meet ASTM 536-84.

2.2 FITTINGS

A. Chilled and Hot Water Piping:
   1. ½" through 2" - Wrought copper sweat fittings.
   2. 2½" and larger - Welded long-turn fittings and flanged connections.

B. 150 lb. ASA forged.

C. Dissimilar Metals require di-electric unions.

2.3 TRIPLE DUTY VALVES

A. Type:
   1. Combination non-slam valve, throttling valve, shut-off valve and calibrated balancing valve, backseating valve stem, NPT & flanged connections.

B. Materials:
   1. Body:
      a. NPT & flanged models - cast iron
      b. Grooved models - ductile iron
   2. Seat - Brass
   3. Disc - Bronze with EPDM seat insert
   4. Stem - Flanged & grooved models - stainless steel
   5. Spring - Stainless steel
   6. Packing - Teflon-Graphite

C. Operating Pressure:
   1. Maximum working pressure:
      a. Cast iron models - 175 PSIG
      b. Ductile iron models - 300 PSIG
   2. Maximum operating temperature:
      a. 250°F

D. Maximum Pressure Drop:
   1. 2 PSIG across valve

E. Manufacturers:
   1. Bell & Gossett
   2. Armstrong
   3. Meuller

F. Application:
   1. Discharge side on all pumps

2.4 SUCTION DIFFUSERS

A. Type:
   1. Straight or angle fitting, with pipe support foot, strainer orifice cylinder with start-up strainer (#16 MESH Bronze) and permanent strainer, permanent magnet, horizontal service only.

B. Materials:
   1. Body - NPT & Flanged Models - cast iron. Meets ASTM A126 or ASTM A536.
   2. Cover - Grooved models - ductile iron
   3. Straightening - X Models - Steel
   4. Vanes - Z & Grooved Models - Stainless steel
   5. Orifice - X Models - Steel
   6. Cylinder - Z & Grooved Models - Stainless steel
   7. Start Up Strainer - X, Z & Grooved Models - 16 Mesh Bronze
   8. O Ring Seal - All Models - EPDM

C. Operating Pressures:
   1. Maximum Working Pressure:
      a. Cast iron models - 175 PSIG
      b. Ductile iron models - Grooved system with flanged pump connection - 175 PSIG

D. Manufacturers:
   1. Armstrong
   2. Bell & Gossett

E. Application:
   1. Suction side on all pumps. Install such that strainer is serviceable from horizontal position.

2.5 CHECK VALVES

A. 2 inch diameter pipe and smaller:
   1. Type:
      a. 300 pound CWP/150 pound SWP horizontal swing
   2. Material:
      a. Body - Bronze Y-Pattern
      b. Seat - Bronze or TFE
      c. Cap - Screwed
      d. Connection - Screwed

3. Manufacturer/Model:
    a. Nibco T-433-B
    b. Crane 141-TF
    c. Jenkins 4092-J
    d. Milwaukee 508

B. Larger than 2 inch diameter:
1. Type:
    a. No slam globe style check.
    b. 200 pound CWP
2. Material:
    a. Body - Cast iron
    b. Hanger, disc and seat ring - Cast bronze
    c. Seat and disc - Renewable
    d. Connection - Flanged
3. Manufacturer/Model:
    a. Nibco F-910-B
    b. APCO Series 600
    c. Combination Pump & Valve # 20-D
    d. Milwaukee 1800

2.6 GATE VALVES

A. Larger than 2 inch diameter:
1. Type:
    a. 200 pound CWP OS & Y design
2. Material:
    a. Body and bonnet - Cast iron
    b. Wedge bushing, seat ring and wedge face ring - Cast bronze
    c. Bonnet - Bolted
    d. Wedge - Solid
    e. Connections - Flanged
3. Manufacturer/Model:
    a. Nibco F-617-0
    b. Crane 465 1/2
    c. Jenkins 454-J
    d. Milwaukee 2885-A
4. Application:
    a. ON/OFF

B. All valves are to have insulated extension handles.

2.7 BALL VALVES

A. 2 Inch and smaller.
1. Type:
    a. 150 pound CWP two piece design, full port
2. Material:
    a. Body - ASTM B-584, Alloy 844, Bronze. Yellow brass with more than 15% zinc not acceptable
    b. Seat - TFE
    c. Stem - Blowout-proof
    d. Handle - 1/4 turn lever
    e. Memory stop
3. Manufacturer/Model:
    a. Nibco T-585-70-M

b. Apollo 77-150 Series
c. Milwaukee BA-400

4. Application:
a. ON/OFF

B. Where piping is insulated, ball valves shall be equipped with 2-inch extended handles of non-thermal conductive material. Also, provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation. Supply with memory stops which are fully adjustable after insulation is applied. Equal to Nibco Nib Seal handle.

2.8 CHEMICAL POT FEEDER (CLOSED SYSTEM FILTER FEEDER)

A. Type: Neptune DBF-5HP or equivalent

B. Stainless steel basket

C. 30 micron polypropylene felt filter bag

D. Filtered rate 100 gpm

E. 5 gallon capacity

F. Construction:
1. SAE 1020 stainless
2. Finished 20 coat epoxy
3. 150 PSI, 200°F

G. Furnish 6 extra bags per feeder provided.

H. Manufacturers:
1. Neptune
2. Efficiency Dynamics
3. Claypool Pump & Machinery Co.
4. Newton Chemical Pump Co.
5. Wingert

I. Location:
1. Across pumps and as recommended by manufacturer

2.9 BUTTERFLY VALVES

A. 2" - 12" diameter:
1. 200 PSI
2. Ductile iron ASTM A-536
3. Full lug body

B. Disc:
1. Aluminum Bronze ASTM B-148
2. Stainless Steel ASTM A-351
3. Coated ductile iron ASTM A-536

C. Stem and body seal:
1. 410SS and EPDM Rubber rated at 225 degrees F.

D. Collar bushing:
1. Brass

E. Connection:
   1. Flanged

F. 6” & smaller with 10 degree notched lever handle; 8” & larger with cast iron weatherproof gear operator.

G. All valves shall be certified for bi-directional dead-end service without a downstream flange.

H. Manufacturers:
   1. NIBCO #LD-2000 Series
   2. DeZurik # BRS-C1-EPDM-BZ-S4 Series
   3. Demco 2’-12” NE Series; 14” & larger NF-C Series

I. Application:
   1. ON/OFF

2.10 CIRCUIT BALANCING VALVES

A. Type: Automatic flow control valve and accessories.

B. General:
   1. Valve to have internal cartridge(s) that is preset to specific GPM flow rate. Body to have arrow indicating flow direction. Accuracy to be ± 5%.
   2. Operating range to be 2-45 PSI, 175 PSI working pressure, 250ºF.
   3. Provide pressure/temperature ports for flow verification rating.
   4. Provide ID tag with model number, GPM, spring range and location.
   5. Body to be brass or ductile iron. Valves 2-inch and smaller to be brass Y-body type screwed ends, union, ball valve. Valves 2½- inch and larger to be flanged end, ductile iron.

C. Manufacturers:
   1. Nexus
   2. Flo Design
   3. Tour
   4. Anderson
   5. Griswall
   6. Belimo

2.11 STRAINERS

A. Type:
   1. 150 pound W.O.G., "Y" type, Mueller, Nibco

B. Material:
   1. ASTM B-62 Bronze
   2. ASTM A126, Class B cast iron

C. Connection:
   1. Screwed

D. Screen:
   1. Mesh size:
      a. 20 by 20 or 0.045 inch perforation
      b. Up to 2": #20 mesh screw
      c. 2½" - .63
      d. 5" and up: 0.125

E. Material:
   1. Brass or stainless steel

F. Application:
   1. At coils, pumps, heating/cooling equipment
   2. Automatic flow-control valves shall not be used on equipment where pressure independent control valves are installed. Coordinate with control valve provider.

2.12 TEST PLUGS

A. Provide where indicated for temperature and/or pressure measurement.

B. Furnish Owner with 2 sets of suitable pressure and temperature gauges.

C. Solid brass with cap and gasket.

D. **Provide 6 extra plugs located by Test & Balance Contractor. Coordinate these with Test and Balance Contractor.**

2.13 COMBINATION AIR ELIMINATOR AND DIRT SEPARATOR

A. Automatic, full flow coalescing type combination air eliminator and dirt separator shall be fabricated steel, rated for 150 psig working pressure, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels, and include two equal chambers above and below the inlet / outlet nozzles.

B. Unit shall be based upon system flow with pipe size as a minimum. In no case shall entering velocity exceed 10 feet per second.

C. Unit shall include internal structured elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. The elements must be fabricated by the manufacturer and consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.

D. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.

E. Units shall include a side tap valve to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

F. Working Temperature:
   1. Up to 240°F.

G. Manufacturer/Model:
   1. Spirotherm
   2. Thrush
   3. Elbi
   4. Wessels

H. Location:
   1. A straight run of horizontal piping on the suction side of pumps.

2.14 EXPANSION TANKS

A. Material:
   1. Shell: Steel ASME Rated with Seal

B. Manufacturer
   1. Armstrong
   2. Thrush
   3. Elbi
   4. Wessels

C. Types:
   1. Hanging: Armstrong AX Horizontal Diaphragm or equivalent
   2. Floor Mount: Armstrong L Vertical Replaceable Bladder or equivalent

D. Location:
   1. As shown on schematic and recommended by manufacturer

2.15 DUAL CONTROL VALVES

A. Type:
   1. Reducing (fast-fill) valve and pressure relief valve in one pre-assembled unit.

B. Material:
   1. Cast iron

C. Inlet & outlet size:
   1. 1/2 inch diameter

D. Pressure:
   1. Relief valve:
      a. Factory preset: 30 psi
      b. Delivery: 12 psi
   2. Filling valve:
      a. Initial: 45 psi

E. Features:
   1. Adjustable filling valve pressure setting.
   2. Built-in strainer.
   3. Built-in back pressure check.
   4. Time-saving thumbscrew adjustment.

F. Manufacturer/Model:
   1. Amtrol 67F.

2.16 BACKFLOW PREVENTER

A. Material:
   1. Bronze.

B. Connections:
   1. Screwed.

C. Equip with standard gate valves.

D. Manufacturer/Model:
   1. Watts 909.

E. Provide access for testing all ports 6'-0" or lower AFF.

2.17 HEATING CABLES

A. 8 Watts per linear foot, UL Listed

B. Manufacturers
   1. Chromalox SRL with DL Series Thermostat
   2. Raychem XL-Trace with Thermostat
   3. Equivalent manufacturer must be approved 10 days prior to bid.

2.18 HDPE PRODUCTS

A. Couplings
   1. Sizes 2" through 36" consisting of two ductile iron housings conforming to ASTM A 536, Grade 65-45-12 designed for full installation at pad-to-pad contact. Couplings shall include a Type 301 stainless steel retaining ring teeth to engage the pipe OD and permit installation without fusing equipment. Couplings shall be provided with heat-treated, zinc-electroplated with fluoropolymer top coat carbon steel bolts/nuts, meeting the physical and chemical requirements of ASTM A-449 and physical requirements of A-183, with hardened steel washers to ASTM F436, type 3.} [stainless steel bolts and nuts Type 316], with prelubricated [Grade 'E' EPDM for water services] compound gasket for petroleum products, air with oil vapors, vegetable and mineral oils with operating temperatures to 180°F/82°C and working pressures equal to the adjoining HDPE pipe. (Not recommended for hot water services over 150°F/66°C or hot dry air over 140°F/60°C. Couplings shall be fully installed at visual metal-to-metal contact. (Couplings do not require 'gapping' of bolt pads and/or specific torque ratings.)

B. HDPE Pipe Flange Adapters
   1. For direct connection to ANSI Class 125 and 150 flanged components. Adapters shall consist of ductile iron housings, conforming to ASTM A395, Grade 65-45-15, and A536, Grade 65-45-12, with integral rows of gripping teeth machined into the HDPE side of housing. Adapter bolts shall be heat treated carbon steel trackhead the chemical and physical requirements of ASTM A-449 and the conforming to physical requirements of ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) zinc plated to ASTM B-633 with fluoropolymer top coat. Optional stainless steel to ASTM A-193 Grade B8, Class 2 (type 304) or grade B8M, class 2 (type 316). Gasket shall be pressure responsive synthetic rubber. (Grade to suit the intended service.)

C. Valves
   1. 3 inch through 36 inch: In-coupling valve accepts [grooved ends for steel pipe] [plain end HDPE pipe (3-inch through 8-inch)], rated for working pressure to 150-psi (1035-kPa). Valve shall consist of an electroless-nickel coated ductile iron body with ductile iron packing gland, stroke limiter, and yoke conforming to ASTM A536, Grade 65-45-12, 316 stainless steel gate and stem, and 416 stainless steel clean-out plug, 17-4 stainless steel bushing and drive nut, polyurethane seat and knife seal, [EPDM] [Lubricated Nitrile] pipe gasket, and [handwheel] [bevel gear] [pneumatic cylinder] [hydraulic cylinder] [multi-turn electric] operator.
   2. Suitable for fluid lines containing solids and abrasive materials.
   3. Suitable for on-off service; shut-off isolation without expelling media from the bottom of the valve.
   4. Knife, seat, and packing replaceable without removing the valve from the piping system.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Provide valves, strainers, expansion tanks, air separators, air eliminators, and other equipment shown on the plans, and as otherwise necessary for a complete operational, maintainable, and reliable system.

B. Installation shall be in accordance with the plans, specifications, and manufacturer's instructions.

C. Install one chemical/filter feeder per system.

3.2 ARRANGEMENT

A. All piping shall be run parallel to building lines and shall be arranged so as not to interfere with removal of other equipment or devices nor to block access to doors, windows, manholes or other access openings.

B. Piping shall be arranged so as to facilitate removal of tube bundles.

C. Piping shall be placed and installed so that there will be no interference with the installation of the equipment, ducts, etc.

D. All piping shall be installed to ensure noiseless circulation.

E. All valves and specialties shall be placed to permit easy operation, maintenance and access.

F. All piping shall be erected and pitched to ensure proper draining.

G. All backflow preventers shall be installed with test ports lower than 6’-0” AFF.

H. Piping shall be installed so as to avoid liquid or air pockets throughout the piping system.

I. Eccentric reducers with flat side up shall be used wherever changes in pipe size would cause an air trap.

J. Manual air vents shall be installed at all high points in chilled water and hot water heating systems with piping to drains.

K. Drain valves - Install in all low points or traps in the piping system.

L. Expansion and contraction of piping shall be provided by expansion loops, bends or expansion joints to prevent injury to connections, piping, equipment or the building.

3.3 SLOPE

A. Minimum slope of piping shall be in accordance with the following unless otherwise specifically shown on the drawings or specified.

Type of Piping or Fluid Conveyed	Length for System Component	One Inch Fall	Direction of Fall
Chilled Water	Runouts to Equipment or Risers	4 feet	Back to Mains

Type of Piping or Fluid Conveyed	Length for System Component	One Inch Fall	Direction of Fall
Chilled Water	Supply and Return Mains	40 feet	To Nearest Drain Valve

3.4 CLEANING AND FLUSHING OF PIPING SYSTEM

A. Remove all labels, dirt, paint, grease and stains from all piping and accessories installed under this Contract.

B. A temporary flushing connection shall be arranged for each section of piping.

C. Water required for flushing shall be furnished by the Contractor.

D. All temporary cross connections for flushing and drainage connection shall be furnished, installed and subsequently removed by the Contractor.

E. Flush the entire system of all cutting oil, slag, pipe debris using a 1-2% solution of sodium triphosphate for a minimum of forty-eight (48) hours under pressure. Repeat if necessary. Flush with clean water until clear.

F. Contact Owner to coordinate with Owner's chemical treatment contractor to verify that the system has been properly cleaned. Contract with Owner’s chemical treatment to add required chemicals to system to prevent corrosion, etc.

G. All fan coil units and air handlers shall be connected such that flow bypasses the cooling and heating coils, automatic flow control valves and the control valves during this process.

H. After the system is properly cleaned, the Contractor shall properly connect the fan coil units and air handlers.

I. After system cleaning, open all strainers, remove screen and clean strainers and re-install.

J. Remove all air from system.

K. In filling the systems, be sure to vent in such a manner that the control valves cannot backfill, thus causing foreign matter to be introduced into the valve body.

3.5 WATER TREATMENT

A. None of the systems shall be operated during construction without water treatment. Chemicals shall be introduced into the system within 8 hours of filling. The treatment shall be by the Owner’s Contractor. The Contractor shall notify and coordinate with the Owner when the piping systems are complete and ready for treatment.

3.6 HEATING CABLE

A. Provide and install heating cable on all piping installed outside. Install heating cable on bottom of pipe using plastic wire ties every 5-feet and within 6-inches of any turn in pipe. Install thermostat on top of pipe.

3.7 TESTING

A. Apply a hydraulic pressure 1-1/2 times the operating pressure, 150 psig minimum, and carefully check for leaks.

B. Repair all leaks and retest the system until proved watertight.

C. Clean strainers after start-up and before test and balance agency performs their work.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SCOPE

A. Pumps for use in distributing hot and chilled water for space heating and cooling.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 19 - Meters and Gauges for HVAC Piping

C. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

D. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

E. Section 23 09 23 - Energy Management Control System

F. Section 23 21 13 - Hydronic Piping, Valves, and Appurtenances

1.4 REFERENCES

A. HI - Hydraulic Institute.

B. ANSI - American National Standards Institute.

C. OSHA - Occupational Safety & Health Administration.

D. ASHRAE - American Society of Heating, Refrigeration and Air-Conditioning Engineers.

E. NEMA - National Electrical Manufacturers Association.

F. UL - Underwriters Laboratories.

G. ETL - Electrical Testing Laboratories.

H. NEC - National Electric Codes.

I. ISO - International Standards Organization.

J. IEC - International Electrotechnical Commission.

K. ASME - American Society of Mechanical Engineers

1.5 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 00, General Conditions, and Division 1.

1.6 QUALITY ASSURANCE

A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.

B. Ensure pump operation at specified system fluid temperatures without vapor binding and cavitation, is non-overloading in parallel or individual operation, and operates to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer. The pump NPSH shall conform to the ANSI/HI 9.6.1-2012 standards for *Centrifugal and Vertical Pumps for NPSH Margin*.

C. Ensure pump pressure ratings are at least equal to system's maximum operating pressure at point where installed but not less than specified.

D. Equipment manufacturer shall be a company specializing in manufacture, assembly, and field performance of provided equipment with a minimum of 20 years.

E. Equipment provider shall be responsible for providing certified equipment start-up. New pump start-up shall be for the purpose of determining pump alignment, lubrication, voltage, and amperage readings. All proper electrical connections, pump's balance, discharge and suction gauge readings, and adjustment of head, if required. A copy of the start-up report shall be made and sent to both the contractor and to the Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site in such a matter as to protect the materials from shipping and handling damage. Provide materials on factory provided shipping skids and lifting lugs if required for handling. Materials damaged by the elements should be packaged in such a manner that they could withstand short-term exposure to the elements during transportation.

B. Store materials in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage.

C. Use all means necessary to protect equipment before, during, and after installation.

D. All scratched, dented, and otherwise damaged units shall be repaired or replaced as directed by the Architect/ Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Armstrong

B. Bell & Gossett

C. Paco

D. Taco

E. Grundfos

2.2 GENERAL

A. Furnish and install as scheduled and shown on plans, centrifugal pumps.
   1. Motor:
      a. Premium efficiency motors shall be of the horsepower and speed shown in the pump schedule. Pumps requiring larger horsepower shall not be acceptable. Motor shall be premium efficiency and totally non-overloading on the pump curve.
      b. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans.
      c. Pump and motors shall be factory aligned.
      d. It shall have heavy-duty grease-lubricated ball bearings, completely adequate for the maximum load for which the motor is designed.
         (1) Acceptable Motors: Century E-Plus 3, US Premium Efficiency, Reliance XE, Baldor Super E or approved equivalent.
   2. Base:
      a. Entire pumping unit shall be mounted on a cast iron driprim base using cap screws. Pumps shall not be secured with floor studs.
   3. Efficiency:
      a. Pump(s) shall meet or exceed the efficiency shown in the pump schedule.
   4. NPSHR:
      a. To ensure cavitation-free operation, each pump's NPSH Requirement must be low enough to permit stable, continuous operation at 120% or greater of best design point.
   5. Noise:
      a. Each pump shall be capable of continuous operation without producing noise in excess of Hydraulic Institute and OSHA guidelines.
   6. Test:
      a. Each pump shall be factory hydraulically tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

2.3 CENTRIFUGAL PUMPS

A. Split Coupled End-Suction Pumps:
   1. Furnish and install pumps with capacities as shown on plans. The pumps shall be long coupled, base mounted, single stage, end suction, vertical split case design, in cast iron and stainless steel fitted, and specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure or optional operations at up to 250°F and 250 PSIG working pressures. Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections, electrical motor connections or pump to motor alignment.
   2. The pumps shall be composed of three separable components: a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupling.
   3. A bearing assembly shall support the shaft via two heavy-duty re-greaseable ball bearings. Bearing assembly shall be replaceable without disturbing the system piping and shall have foot support at the coupling end. Pump bearings shall be re-greaseable without removal of the bearings from the bearing assembly. Thermal expansion of the shaft toward the impeller shall be prevented via an inboard thrust bearing.
   4. The bearing assembly shall have a solid SAE1144 steel shaft. A stainless steel shaft sleeve shall be employed to completely cover the wetted area under the seal.

5. Pump shall be equipped with an internally-flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Application of an internally flushed mechanical seal shall be adequate for seal flushing without requiring external flushing lines. Seal assembly shall have Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
6. Bearing assembly shaft shall connect to a bronze impeller. Impeller shall be both hydraulically and dynamically balanced to ANSI/HI 9.6.4-2009, balance grade G6.3 and secured by a bronze locking capscrew or nut.
7. Pump should be designed to allow for true back pull-out allowing access to the pump's working components, without disturbing motor or piping, for ease of maintenance.
8. A center drop-out type coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupling sleeve. Coupling shall allow for removal of pump's wetted end without disturbing pump volute or movement of the pump's motor and electrical connections. On variable speed applications the coupling sleeve should be constructed of a neoprene material to maximize performance life.
9. An ANSI and OSHA rated coupling guard shall shield the coupling during operation. Coupling guard shall be dual rated ANSI B15.1 and OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling. No more than .25 inches of either rotating assembly shall be visible beyond the coupling guard.
10. Pump volute shall be of a cast iron design with integrally cast pedestal volute support, rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. (Optional 250 PSIG working pressures are available and are 250# flange drilled.) Volute shall include gauge ports at nozzles, and vent and drain ports.
11. Base plate shall be of structural steel or fabricated steel channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area (for field grouting). The minimum base plate stiffness shall conform to ANSI/HI 1.3.8.2.1- 2009 for grouted Horizontal Baseplate Design standards.
12. Pump shall be of a maintainable design and, for ease of maintenance, should use machine fit parts and not press fit components.
13. The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 9.6.4-2009 for recommended acceptable unfiltered field vibration limits (as measured per ANSI/HI 9.6.4-2009 Figure 9.6.4.2.3.1) for pumps with rolling contact bearings.
14. Pump manufacturer shall be ISO-9001 certified.
15. Each pump shall be hydrostatically tested 1.5 times the maximum rated working pressure and name-plated before shipment.
16. Pump shall conform to ANSI/HI 9.6.3.1-2012 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.

B. Closed Coupled Pumps:
1. Furnish and install pumps with capacities as shown on plans. The pumps shall be close-coupled, foot mounted, single stage, end suction, vertical split case design, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 225° F and 175 PSIG working pressure or optional temperatures to 250°F. Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
2. The pumps shall have a solid alloy steel shaft that is integral to the motor. A stainless steel shaft sleeve shall be employed to completely cover the wetted area under the seal.
3. The motor bearings shall support the shaft via heavy-duty grease lubricated ball bearings.
4. Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have Buna bellows and seat gasket, stainless steel spring, and be of a carbon / ceramic design with the carbon face rotating against a stationary ceramic face.
5. Motor shaft shall connect to a bronze impeller. Impeller shall be hydraulically and dynamically balanced to ANSI/HI 9.6.4-2009, ISO 1940 balance grade G6.3, keyed to the shaft and secured by a bronze locking cap screw.

6. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
7. Pump volute shall be of a cast iron design for HVAC systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges NPT pipe. Volute shall include gauge ports at nozzles, and vent and drain ports.
8. Pumps shall conform to ANSI/HI 9.6.3.1-2012 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer. The pump NPSH shall conform to the ANSI/HI 9.6.1-2012 standards for Centrifugal and Vertical Pumps for NPSH Margin.
9. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
10. Pump manufacturer shall be ISO-9001 certified.
11. Each pump shall be factory tested and name-plated before shipment

C. Vertical In-Line:
1. The pumps shall be close-coupled, inline for vertical or horizontal installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure (or optional operations at up to 250°F and 250 PSIG working pressures). Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
2. As an option an EPR/Carbon/Tungsten/Carbide/SS seal (250°F maximum operating temperature), FKM/Carbon/Ceramic/SS seal, or EPR-Silicon Carbide/Silicon Carbide/SS seal may be used in lieu of the standard Buna/Carbon/Ceramic/SS seal (225° F maximum operating temperature).
3. The pumps shall have a solid alloy steel shaft that is integral to the motor. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
4. The motor bearings shall support the shaft via heavy-duty grease lubricated ball bearings.
5. Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have a stainless steel housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
6. Pump shaft shall connect to a bronze impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.5-2000. The allowable residual imbalance conforms to ANSI grade 6.3, keyed to the shaft and secured by a bronze locking cap screw or nut.
7. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
8. Pump volute shall be of a Class 30 cast iron design rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges (Optional 250 and 300 PSIG working pressures are available and are 250# flange drilled). Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.
9. Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.
10. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
11. Pump manufacturer shall be ISO-9001 certified.
12. Each pump shall be factory tested and name-plated before shipment.
13. As an option, the pump may include an internal stainless steel casing wear rings.
14. Where noted on schedule pumping equipment may require one or all of the following optional tests: Certified Lab tests (unwitnessed), Hydraulic Institute Level B tests, or Witnessed Tests.

D. Double Suction, Vertical Split Case (Base Mounted):
   1. The pumps shall be long coupled, base mounted, single stage, double suction, vertical split case design, in cast iron bronze fitted construction specifically designed for quiet operation. Suitable for standard operations at 300°F and 175 PSIG working pressure or optional operation up to 300 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 300°F.
   2. The bearing housing shall supply support for heavy-duty single row permanently lubricated ball bearings, with provision for purging or flushing if desired. Polyurea grease, capable of handling both high and low temperatures and that is resistant to washout and condensation shall be provided. The bearings shall be capable of absorbing both radial and thrust loads and maintaining the rotating element in proper axial alignment. Bearings shall be capable of being inspected and repaired by removal of only a bearing bracket.
   3. The impeller shaft shall be of solid 1045 steel with 304 SS sleeves covering the wetted area of the shaft. 12x14x22, 14x16x22, 16x18x19, and 18x20x22 sizes shall be fitted with solid 416 SS shaft; heat-treated to 80 KSI yield strength. Pump shall be equipped with internally flushed unitized mechanical seal assemblies, mounted on 304SS sleeves, installed in enlarged tapered seal chambers. Application of an internally flushed mechanical seal shall be adequate for seal flushing without requiring external flushing lines.
   4. Mechanical seal assemblies shall be unitized, single spring, EPR elastomer bellows with drive ring, Carbon face rotating against a stationary Silicon Carbide face allowing for fast and easy installation and replacement. Seals shall be capable of being inspected and easily repaired.
   5. Impeller shall be of the enclosed double suction type made of low zinc silicon brass, both hydraulically and dynamically balanced to ISO 1940-1:2003 balance grade G6.3 and keyed to the shaft.
   6. A coupling, capable of absorbing torsional vibration and of operating in variable speed applications, shall be employed between the pump and motor. An optional Spacer Coupler shall allow for removal of pump's wetted end without disturbing pump volute or movement of the pump's motor and electrical connections.
   7. An ANSI B15.1 and OSHA 1910.219 compliant coupling guard shall shield the coupler during operation. Coupler guard shall be dual designed and contain viewing windows for inspection of the coupling. No more than .25 inch opening in the guard around the rotating assembly shall be visible.
   8. Pump volute shall be of cast iron ASTM A159 material (35,000 psi) design with an integrally cast pump discharge and an integrally cast pump suction. Flanges shall be extra heavy-duty design and will be of 250# thickness while capable of being drilled for 125# ANSI flat face use. Volute shall have integrally cast support feet, gauge ports at nozzles, and vent and drain ports.
   9. Base plate shall be welded structural steel fully enclosed at sides and ends, with securely welded cross members. The minimum base plate stiffness shall conform to ANSI/HI 1.3-2000, section 1.3.5.3 for Horizontal Base Plate Design standards. First modal frequency of the base shall be no less than 20% higher than the maximum operating speed (29.7 Hz at 1780RPM) of the unit.
   10. Pump rotation shall be right-hand or left-hand as viewed from the pump's motor end and in respect to the discharge flange.
   11. Pump shall be of a maintainable design for ease of maintenance and should use machine fit parts that are easily disassembled.
   12. The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5, section 1.4.6.1.1 for recommended acceptable unfiltered field vibration limits (as measured per HI 1.4.6.5.2, Figure 1.108) for pumps with rolling contact bearings. Pump manufacturer shall be ISO-9001 certified.
   13. The seismic capability of the pump shall allow it to withstand a horizontal load of 0.5g, excluding piping and/or fasteners used to anchor the pump to mounting pads or to the floor, without adversely affecting pump operation.

14. Each pump shall be hydrostatically tested and painted with one coat of high quality factory approved paint and name-plated before shipment from the factory.

2.4 ACCESSORIES

A. Provide one mechanical seal for each model type of primary pump.

B. Pumps shall be provided with internal volute wear rings, galvanized drip pan, or special spacer couplings.

PART 3 EXECUTION

3.1 INSTALLATION

A. All components shall be installed in accordance with manufacturer's installation instructions.

B. Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.

C. Furnish and install triple duty valves on the discharge side of all pumps and furnish and install a line size shut-off valve on the suction side of all pumps. Anywhere that 5 straight pipe diameters of pipe cannot be provided on the inlet side of a pump a suction diffuser shall be used to provide appropriate flow distribution into the eye of the pump's impeller.

D. Provide temperature and pressure gauges where and as detailed or directed.

E. On systems where pump seals require flushing water or cooling water for a heat exchanger kit, provide cooling water supply piping and connections as well as the return piping, if required. Piping should be of adequate size to pass required flow rate.

F. Proper access space around a device should be left for servicing the component. No less than the minimum recommended by the manufacturer.

G. Provide an adequate number of isolation valves for service and maintenance of the system and its components.

H. On systems where the final balancing procedure requires the triple duty valve to be throttled more than 25% to attain design flow (on a constant speed pumping system), and no future capacity has been built into the pump, the pump impeller must be trimmed to represent actual system head resistance. The pump provider and engineer of record, based on the balancing contractor's reports, shall determine the final impeller trim diameter.

I. Each pump shall have at minimum a 4" housekeeping pad.

J. Install foot mounted and base mounted pumps on a vibration isolation pad, which will be set on top of the housekeeping pad. Set, level and grout. Install non-shrinking grout under pumps.

K. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads of stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

L. On components that require draining, contractor must provide piping to and discharging into appropriate drains.

M. Provide drains for bases and seals, piped to and discharging into floor drains.

N. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instruction and applicable state, federal, and local codes.

O. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the control's contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal, and local codes.

P. The pumps shall be installed at the locations shown and as detailed on the plans and in other sections of these specifications.

Q. The mechanical contractor shall clean the strainers and suction diffusers after the system has been flushed and on a regular basis until the pumps are turned over to the Owner.

R. Pump and motor shall be realigned by the contractor according to the standards of the Hydraulic Institute after grouting of base and connection of piping.

S. Each pump shall be checked by the contractor and regulated for proper differential pressure, voltage and amperage draw. This data shall be noted on a permanent tag or label and fastened to the pump for Owner's reference.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Refrigerant piping for split system (including heat pumps) cooling/heating units.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 07 19 - Hydronic Piping Insulation

C. Section 23 07 21 - Refrigerant Piping Insulation

D. Section 23 33 33 - Access Doors

1.4 REFERENCES

A. ASTM B280 - Seamless Copper Tube for Air Conditioning & Refrigeration Service

1.5 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 1.

1.6 COORDINATION

A. Coordinate the refrigerant line sizing, lengths, traps, and all other aspects of the refrigerant systems with the air conditioning unit manufacturer to ensure a completely working and reliable system.

B. Submit product data on piping materials and fittings.

C. Provide letter stating air conditioning manufacturer has reviewed refrigerant line design. Provide drawings on any lines that are longer than 80 feet.

D. If units have to be moved due to line lengths, then all associated costs will be at the Contractor's expense.

PART 2 PRODUCTS

2.1 PIPING

A. ACR hard drawn copper tubing, conform to ASTM B280.

B. ACR soft drawn copper tubing is allowed in concealed locations, such as behind walls. Above ceiling is not considered a concealed location.

2.2 FITTINGS

A. Wrought copper fittings

B. Use silver solder at connections

2.3 VALVES

A. Manufacturers:
   1. Alco Controls
   2. Sporlan Valve Company

PART 3 EXECUTION

3.1 MATERIAL PREPARATION

A. Cut tubing with a sharp pipe cutter.

B. Ream and thoroughly clean to remove all burrs, filings, dirt and grease before assembly and soldering.

C. Remove oxide and discoloration prior to assembly.

3.2 SLEEVES

A. Sleeve piping as required in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

B. All refrigerant piping passing under slab shall be sleeved.

C. Sleeves shall be of an adequate size to permit removal of the piping at a later date.

3.3 HANGER SUPPORTS

A. Support as required in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

B. Do not fasten liquid and suction lines together unless there is insulation between them. Use wire ties. Duct tape not allowed.

C. Insulate all refrigerant lines from structure.

3.4 INSTALLATION

A. Route with building lines, vertical lines to be plumb, grade horizontal suction lines to compressor.

B. All brazing shall be done with 2-8 psig dry nitrogen purge.

C. Protect all valves and paint from excessive heat.

D. Keep refrigerant lines sealed from atmosphere during construction.

E. All suction lines to receive insulation.

F. No welded or mechanical joints in concealed areas, such as walls. Soft drawn copper is acceptable.

G. Follow A/C manufacturer's instructions.

END OF SECTION

SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Bypass chemical-feed equipment and controls.
   2. Automatic chemical-feed equipment and controls.
   3. Chemical treatment test equipment.
   4. HVAC water-treatment chemicals.

B. Project Coordination:
   1. Mechanical shall subcontract the Owner's water treatment contractor.
   2. Hydronic system material and labor for the system cleanup shall be provided by the mechanical contractor. All items not specifically addressed as "provided by owner" will be provided and installed by the mechanical contractor.
   3. All chemicals used for cleanup and system startup shall be provided by the water treatment contractor.
   4. Mechanical contractor to coordinate and confirm with water treatment contractor where piping connections need to be.
   5. Mechanical contractor to coordinate and confirm with water treatment contractor where racks, pumps, feeders and tanks be located.

C. Provide a complete chemical water treatment program during construction for all new and reused piping networks. This program shall begin from the point each system is filled during construction and extend until Substantial Completion or final Owner acceptance of each system, whichever occurs later. The program shall include water analysis, chemicals, testing, equipment, consulting and service for all the systems.

D. Chemically treat new and reused piping networks using chemicals and treatment procedures compatible with the system being cleaned and the chemical treatment chemicals in existing piping systems being connected to. Test existing piping systems or otherwise determine chemical treatment in existing piping and validate compatibility

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids.

E. UV: Ultraviolet.

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC 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.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating chilled water, shall have the following water qualities:
   1. pH: Maintain a value within 8.8 to 10.
   2. Turbidity: Maintain a value less than 15 NTU.
   3. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   4. Boron: Maintain a value within 100 to 200 ppm. (Glycol system) and less than 10 ppm for the closed hydronic system.
   5. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   6. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   7. TDS: Maintain a maximum value of 10 ppm.
   8. Ammonia: Maintain a maximum value of 5 ppm.
   9. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
   10. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
      c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
      d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
      e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

D. Treatment:
   1. Low temperature hot water, closed cooling and chilled water - Mixture of sodium nitrite, borax and molybdate with other copper alloy inhibitor. For the chilled water a non-nitrite program of phosphate, polymer borate and copper alloy inhibitors: non-oxidizing, non-cationic biocide.

E. Open hydronic systems, including condenser water, shall have the following water qualities:
   1. pH: Maintain a value within 7.0 to 9.0.
   2. Langelier Saturation Index: Maintain a maximum value of +2.5 ppm
   3. Conductivity: Maintain a minimum value of 2400 uhmos. The goal of the plant is to run the highest conductivity possible for water conservation
   4. Silica: Maintain a maximum value of 125 ppm
   5. "P" Alkalinity: Maintain a maximum value of 100 ppm.
   6. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   7. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   8. TDS: Maintain a maximum value of 10 ppm.
   9. Ammonia: Maintain a maximum value of 20 ppm.
   10. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm
   11. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
      c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
      d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
      e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.
   12. Polymer Testable: Maintain a minimum value within 10 to 40.

13. Treatment: organic phosphonate and polymeric dispersant with copper alloy inhibitor, or other chromate- free treatment in liquid form; suitable for pumping from containers directly to water system.
    a. Alternate two biocides, one oxidizer and one non-oxidizer; increase dosage when significant amount of algae or slime are detected after system operations.
14. Bleed off:
    a. Automatic control by condenser water conductivity and water meter signals.
    b. To maintain maximum chloride concentration at the maximum level possible based on the incoming water quality up to 7 times concentration of make-up water to minimize corrosion and scale formation.

F. Passivation for Galvanized Steel: For the first 60 days of operation.
1. pH: Maintain a value within 7 to 8.
2. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
3. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.

1.5 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products being used such as but not limited to:
1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. TDS controllers.
6. Biocide feeder timers.
7. Chemical solution tanks.
8. Injection pumps.
9. Chemical test equipment.
10. Chemical material safety data sheets.
11. Multimedia filters.
12. Self-cleaning strainers.
13. Bag- or cartridge-type filters.
14. Centrifugal separators.

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.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Other Informational Submittals:
1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Water Analysis: Illustrate water quality available at Project site.
3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Owner.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.8 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.

1.9 PERFORMANCE REQUIREMENTS

A. Maintain water quality of treated systems to control corrosion, scale and microbiological growth and fouling to ensure maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.

B. Base chemical treatment performance requirements on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
   1. Maintain system essentially free of scale, corrosion, fouling and microbiological control for the Condenser Water and Closed Systems

PART 2 - PRODUCTS

2.1 MANUAL CHEMICAL-FEED EQUIPMENT (HOT WATER, CHILLED WATER SYSTEM)

A. Primary Water Systems: Corrosion coupon rack, minimum of 2 sampling ports, constructed of Black Iron with 0- 10 gpm flow indicator (no dole valves) and an isolation valve on both ends of the rack

B. Manual Chemical Feed Equipment: Bypass Feeders: Steel vertical style with corrosion resistant exterior coating, 3-1/2 inch fill opening in the top, and NPS 3/4 inch bottom inlet and top side outlet, minimum 5 gal, 300 psi. Dome bottom with legs. Pot feeders shall be mounted such that the top of the pot is no more than 4'- 0" above the floor.
   1. The Mechanical contractor shall provide and install the above equipment including all external piping

2.2 AUTOMATIC CHEMICAL-FEED EQUIPMENT (CONDENSER WATER, FLUID COOLER SYSTEM)

A. Utilize Direct Chemical Feed method with Real-time Monitoring and Control of Condenser Water system

B. CONTROLLER: for controlling inhibitor levels in the recirculating tower system with Micro-processor based fluorometer which controls the cooling water inhibitor within

C. +/- 2 ppm of the desired set point. 3D TRASAR Controller with the following capabilities:
   1. Real Time Control - to continually monitor and manage the addition of the corrosion inhibitor, the primary oxidizing biocide and the secondary biocide. It must be capable of measuring the active polymer in the system as well. The inhibitor must control to levels within (+/-) 2 ppm of the desired set point. Inhibitor control is independent of TDS, pH, evaporation, and blowdown.
   2. Conductivity Control - The controller must have the ability to monitor and control conductivity (bleed).

3. ORP & pH Control - The controller must also be capable of monitoring and controlling the condenser water's pH and ORP. This includes a monitoring capability for Turbidity.
4. Corrosion Monitoring - The control system must have in-line mild steel and copper corrosion probes, and be capable of sending those readings to the controller for instantaneous corrosion rate measurements
5. Remote Monitoring - The controller must have the ability for remote monitoring and control, either through a phone line, or a web based system. It must also be able to send Alarms via phones, and/or emails. This output signal can be

D. tied into to an energy management control system to provide operators with data to confirm that inhibitor levels are in range.
   1. BioActivity Control Upgrade - The controller shall be capable of upgrading to include an on-line bioactivity monitoring system with real-time feed based on biological activity.
   2. Alarms - Controller contains several alarms to alert operators when there is: 1. No sample flow 2. High/Low product feed, 3. Limit timer has been exceeded. Operators can simple look at the controller's screen to determine inhibitor levels.
   3. Diagnostic Tool - 3D TRASAR can be used as a diagnostic tool to calculate system volumes, calculate holding time indexes, leak detection studies, etc. Operators can also use the inhibitor data to solve unique problems resulting from improper feed or mixing of the inhibitor in the recirculating system.

E. Chemical Metering Pumps of the positive displacement type, with ball-type check valves and necessary polyethylene discharge tubing for feeding acid, corrosion inhibitor 3DT289, and a non-oxidizing biocide 7338. Pump materials of construction shall be compatible with chemicals being used.

F. Chemical Metering Pump of the diaphragm type, with ball-type check valves and necessary polyethylene discharge tubing for feeding acid, corrosion inhibitor, oxidizing biocide ST20. Pump materials of construction shall be compatible with chemicals being used.

G. 3/4 inch corporation stops to inject chemicals directly in the condenser line that supplies the cooling tower. Corporation stops will be 3/4 inch in diameter. The tip of the corporation stop must reach to the center of the condenser piping to insure prompt mixing of the chemical. Corporation stop injectors will be of PP materials. Oxidizing chemicals will require Kynar material for in the injector. The injector will be installed with a ball valve before the thread-o-let, on the side or bottom of the pipe. The location of the corporation stop injectors will be determined by the water treatment personnel.

H. Bleed Solenoid valve - sized to provide the maximum bleed off required as per system tonnage. Bleed solenoids should be one inch smaller than the size of the make up water meter. Solenoids shall be installed on the condenser line supplying the tower. The solenoid shall be installed at eye level, with a bypass for manual bleed of condenser water.

I. Contacting Water Meter complete with dry contact register sized to meter the maximum makeup and blowdown rate of the system. Meter shall be by Master Meter, Neptune or Carlon Manufacturers. Specify ¾", 1", 1.5", or 2" based on the flow rates below. Water meters are sized at 2 times the maximum makeup for the system design tonnage, Water meters larger than 2 inches shall be a turbine type water meter.

J. Primary Condenser Water System: Corrosion coupon rack, minimum of 4 sampling ports, constructed of Schedule 80 PVC, with 0-10 gpm flow indicator (no dole valves) and an isolation valve on both ends of the rack

K. Inhibitor Injection Timers:
   1. Microprocessor-based controller with LCD display in NEMA 4X, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at BAS.
   2. Programmable timers with infinite adjustment over full range and mounted in cabinet with hand-off-auto switches and status lights.
   3. Test switch.
   4. Hand-off-auto switch for chemical pump.
   5. Illuminated legend to indicate feed when pump is activated.
   6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
   7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.
   8. Timer mode includes: Choice of percent timer, water meter timer, limit timer and 28-day programmable timer

L. pH Controller:
   1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at BAS.
   2. Digital display and touch pad for input.
   3. Sensor probe adaptable to sample stream manifold.
   4. High, low, and normal pH indication.
   5. High or low pH alarm light, trip points field adjustable; with silence switch.
   6. Hand-off-auto switch for acid pump.
   7. Internal adjustable hysteresis or deadband.

M. TDS Controller:
   1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 23 09 00 "Instrumentation and Control for HVAC."
   2. Digital display and touch pad for input.
   3. Sensor probe adaptable to sample stream manifold.
   4. High, low, and normal conductance indication.
   5. High or low conductance alarm light, trip points field adjustable; with silence switch.
   6. Hand-off-auto switch for solenoid bleed-off valve.
   7. Bleed-off valve activated indication.
   8. Internal adjustable hysteresis or deadband.
   9. Bleed Valves:
      a. Cooling Systems:Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
      b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

N. Biocide Feeder Timer:
   1. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
   2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
   3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
   4. Solid-state alternator to enable use of two different formulations.
   5. 24-hour display of time of day.
   6. 14-day display of day of week.
   7. Battery backup so clock is not disturbed by power outages.

8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.

O. Chemical Solution 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.

P. Chemical Solution 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.

Q. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

R. Injection Assembly:
1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Three-piece, stainless steel.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Materials of construction: Stainless steel 316, Nickel alloy, Carpenter 20, PVC
5. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

S. Fail Safes and Alarms:
1. Corrosion safety interlock: Alarm indication, lock-out all chemical feed, open bleed- off valve to flush corrosive water from system
2. PH interlock: Alarm indication, lock-out all chemical feed, open bleed-off valve to reduce total dissolved solids in cooling tower water
3. Flow interlock (on loss of flow): Alarm indication, lock-out all control outputs and chemical feeds

T. Low Level Alarms:
1. Low level alarm system to monitor chemical solution level in inhibitor, pH modifier (acid or alkali), biocide, and dispersant drums
2. Alarm probes, suitable current system capacity and connected with flexible cable
3. Signal output suitable for remote alarm function in addition to local alarm

2.3 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.

D. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless- steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig SWP and 600-psig CWP rating.

2.4 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall- mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
   1. Two-station rack for closed-loop systems.
   2. Four-station rack for open systems.

2.5 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

B. Furnish a one-year's supply of a liquid closed loop inhibitor for control of scale and corrosion in a closed recirculating system. A closed loop is a recirculating system that has less than 10% makeup when compared to its system volume. *This one-year supply shall be a one-time treatment of corrosion inhibitor provided at start up.*

C. Closed Systems: Formulations shall not contain any ingredients that may be harmful to system materials of construction. The corrosion inhibitor shall contain a multi- functional blend of nitrite, tolytriazole, anionic polymer and buffering agent such as Nalco TRAC 102. Provide MSDS sheets on all chemical products. No system shall be operated without the benefit of chemical protection. Once the recommended chemical residual is achieved, any additional chemicals required to re-treat the system due to water loss or to accomplish other work shall be provided by the Mechanical Contractor.

D. Condenser Water System: Formulations shall not contain any ingredients that may be harmful to system materials of construction. The corrosion inhibitor shall contain a multi-functional blend of polymer, dispersants, BZT / tolytriazole, such as Nalco 3DT289. A Dual Biocide application should include Nalco ST20 an Oxidizing Biocide and Nalco 7338 a Non-Oxidizing biocide as recommended by the CDC. Provide MSDS sheets on all chemical products. No system shall be operated without the benefit of chemical protection. Once the recommended chemical residual is achieved, any additional chemicals required to re-treat the system due to water loss or to accomplish other work shall be provided by the Mechanical Contractor

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Mechanical contractor shall coordinate cleaning, flushing and treatment prior to filling and pressure testing system. Once water is added to the system, these processes must begin immediately. At no point should untreated water be circulated in the system outside of these processes. Any damage to the system while operated by the contractor shall be repaired at no cost to the owner

B. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor- mounting accessories to substrate.

C. Mechanical contractor shall insulate all systems in compliance with the mechanical insulation specifications. Direct connections between pipe hangers and piping are prohibited

D. Install water testing equipment on wall near water chemical application equipment.

E. Install interconnecting control wiring for chemical treatment controls and sensors.

F. Mount sensors and injectors in piping circuits.

G. Install corrosion resistant drip pan, a minimum of 3 in high, under tanks and pumps. Intent is to contain minor leaks.

H. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and chilled water and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   2. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   3. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
   4. Install a swing check on inlet after the isolation valve.

I. Install automatic chemical-feed equipment for condenser water and include the following:
   1. Install water meter in makeup water supply.
   2. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
      a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
   3. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   4. Install TDS controller with sensor and bleed valves.
      a. Bleed valves shall cycle to maintain maximum TDS concentration.
   5. Install pH, conductivity and Oxidation-Reduction Potential (ORP) sensors with integral controller, injection pumps and solution tanks.
      a. Injector pumps shall operate to maintain required pH and ORP.
   6. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.
      a. Injection pumps shall operate to feed biocide on an alternating basis.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Mechanical contractor to coordinate and confirm with water treatment contractor where connections need to be.

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.

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet.

E. Backflow preventers required in makeup water connections to potable-water systems.

F. All components shall be installed with unions, flanges, isolation valves, and bypasses where required to maintain system operation during routine maintenance and repair. Under no circumstances should a hydronic system require shutdown to service water treatment equipment

G. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

H. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform startup service.
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
   2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.

B. Test chemical feed piping as follows:
   1. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
   2. 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.
   3. 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.
   4. 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.
   5. Repair leaks and defects with new materials and retest piping until satisfactory results are obtained.
   6. Prepare test reports, including required corrective action.
   7. Inspect field-assembled components and equipment installation, including piping and electrical connections.

8. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
9. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
10. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
11. 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.
12. 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.
13. 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.
14. Repair leaks and defects with new materials and retest piping until no leaks exist.
15. Submit cooling water particle analysis reports showing count and volume of particles within the following micron size ranges: 0.5 to 1, 1 to 2, 2 to 5, 5 to 10, 10 to 20, and 20 and larger at time of startup.
16. Submit cooling water particle analysis reports showing count and volume of particles within the following micron size ranges: 0.5 to 1, 1 to 2, 2 to 5, 5 to 10, 10 to 20, and 20 and larger 30 days after startup.

C. 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.

D. Remove and replace malfunctioning units and retest as specified above.

E. At six-weeks following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

F. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
2. Steam System: ASTM D 1066.
3. Acidity and Alkalinity: ASTM D 1067.
4. Iron: ASTM D 1068.
5. Chloride: ASTM D4458
6. Copper: ASTM D1688
7. pH: ASTM D5464
8. Water Hardness: ASTM D 1126.

3.5 FLUSHING AND CLEANING (EXISTING/EXPANDED/MODIFIED SYSTEMS)

A. Existing systems shall be cleaned and flushed prior to the installation of new work. Existing systems typically have large amounts of debris and contaminants that can cause damage to new components, and once removed, may cause excessive leakage. Every effort shall be made to remove this debris prior to installation and operation of new equipment.

B. Control systems that operate automatic isolation valves, temperature control valves, or other automated hydronic devices must be in place and operational prior to cleaning. Manual operation of automated valves is not acceptable.

C. New equipment shall not be used for the circulation of chemical cleaning solutions intended to remove built-up scale and corrosion in existing piping systems at any point, before or after system modification.
   1. If new pump system is to be used, then include all materials and labor for inspection and cleaning of all wetted parts and replacing of worn items, at a minimum the definite replacement of the seals, after all chemical cleaning and flushing is completed and before system is refilled with final clean fluid

D. When constructing minor piping modifications verify with Owner if the Owner's pumps and strainers can be used for flushing and chemical cleaning operations. When the flushing and cleaning operations are complete, the contractor shall insure the strainer baskets and screens installed in the piping systems permanent strainers replaced with clean elements. Keep temporary strainers in service until the equipment has been tested, then replace straining element with a new strainer and deliver the old straining elements to Owner. Fit the Owners strainers with a line size blowoff valve

E. The mechanical contractor shall:
   1. Fill the system with fresh water. Meter the fill level to ascertain the system volume.
   2. Open/close automated valves as required to achieve flow in all areas.
   3. The Water treatment contractor shall work with the Mechanical contractor to develop a circulation plan that will ensure flow throughout the facility. In variable volume systems, the pumping system is not designed to operate the entire system at design flow. A coordinated isolation plan is required to circulate the system in sections.
   4. The system should be operated as close to 10 ft/sec as possible during the cleaning and flushing operations.
   5. Install all piping main bypasses as required to facilitate cleaning. A temporary flushing connection shall be arranged for each section of piping
   6. All temporary cross connections for flushing and drainage connection shall be furnished, installed and subsequently removed by the mechanical contractor.
   7. All fan coil units and air handlers shall be connected such that flow bypasses the cooling and heating coils, automatic flow control valves and the control valves during the flushing process
   8. Enable the pumps, and circulate the system for forty-eight (48) hours or as determined by the water treatment contractor. The circulation cycle time will vary greatly depending on flow, system size and isolation strategy. Repeat as necessary until system is clear.
   9. Flush the system with fresh water for as directed by the water treatment contractor.
   10. Disable the pumps.
   11. The water treatment contractor will test and verify flush water quality before proceeding.
   12. Drain the system.
   13. Remove all startup strainers from the system, and clean. This includes strainers at pumps, air handlers, terminal devices, fill points, etc.
   14. Purge the dirt separator and replace the side stream filter bag.
   15. Fill the system and chemically clean the system as directed by the water treatment contractor.
   16. Perform additional strainer cleanings in the defined.
   17. Repeat the cleaning process until the water treatment contractor deems the system acceptable.
   18. Perform final flush as directed by water treatment contractor.
   19. The water treatment contractor will test and verify the final flush water condition before proceeding.
   20. Remove all startup strainers from the system and replace with the specified operational strainer. This includes strainers at pumps, air handlers, terminal devices, fill points, etc.

21. Refill system to operating pressure, water treatment contractor shall treat the system for normal operation.
22. In filling the systems, be sure to vent in such a manner that the control valves cannot backfill, thus causing foreign matter to be introduced into the valve body
23. Remove all air from the system
24. The water treatment contractor will provide test reports of system water quality to the owner for verification

F. The water treatment contractor shall:
1. Develop an approved cleaning and treatment plan in coordination with the Mechanical contractor.
2. Utilizing labor provided by the mechanical contractor as needed, flush and chemically clean the hydronic systems as required to obtain completely clean and scale free internal piping surfaces.
3. Acceptable water test results within defined ranges from the main pump location.
4. Acceptable water test results within defined ranges from remote areas in quantities and locations.
5. After system cleaning is complete, provide water treatment as needed to allow the loop water quality parameters to fall within the ranges specified under section “Performance Requirements”.
6. Provide a project closeout report and ongoing maintenance plan to the owner
7. Domestic water test results
8. Initial startup water test results
9. System maintenance schedule
10. Final water test results at conclusion of construction

3.6 ADJUSTING

A. Sample closed water systems at six-weeks after start-up and prepare certified test report for each required water performance characteristic.
1. Nitrite: 500- 750ppm.
2. pH: 8.8 - 9-5
3. Conductivity: 1000 - 3300 michromos

B. Sample condenser water system at six-weeks after start-up and prepare certified test report for each required water performance characteristic.
1. Corrosion Inhibitor Total ppm
2. Corrosion Inhibitor Active ppm
3. Conductivity: 1000 - 3300 michromos
4. Micro-Bio CFU

C. Occupancy Adjustments: Within 12 months of Substantial Completion, perform a separate water analyses to prove that automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis.

3.7 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.

B. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

C. Review manufacturer's safety data sheets for handling of chemicals.

D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 Section "Operation and Maintenance Data."

E. Schedule at least four hours of training with Owner, through Architect, with at least seven days' advance notice.

F. Unit startup by factory authorized agent shall be provided.

END OF SECTION

SECTION 23 31 13

METAL DUCTWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Furnishing and installation of all ductwork as shown on the construction documents. Acoustical and thermal linings and wrappings; flexible ductwork and connections; combination smoke and fire dampers, smoke dampers, and fire dampers; duct access doors; air diffusers, grilles and registers; air volume control devices; hangers and supports; plenums and casings; turning vanes; air filters; installation of temperature control dampers, and other appurtenances necessary for a complete and operational system.

B. All work shall be preceded by taking measurements at the job site, fully coordinating all work with other disciplines, verifying available spaces for ductwork, and developing shop drawings.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

C. Section 23 07 13 - Duct and Grille Insulation

D. Section 23 33 33 - Access Doors

E. Section 23 34 16 - HVAC Fans

F. Section 23 37 13 - Diffusers, Registers, and Grilles

G. Section 23 81 19 - Packaged HVAC Units

H. Section 23 81 26 - Split System HVAC Units

1.4 REFERENCES

A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters

B. AMCA 511 - Certified Ratings Program for Air Control Devices

C. ASTM 653 - Sheet Metal, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanized) by the Hot-Dipped Process

D. ASTM A924 - Hot Dip Galvanized Coils & Sheets - Tolerances

E. ASTM A463 - Steel Sheet Aluminum Coated by the Hot Dip Process

F. NFPA 90A - National Fire Protection Association - Installation of Air Conditioning and Ventilation Systems

G. NFPA 92A - Smoke-Control Systems

H. SMACNA - Sheet Metal and Air Conditioning Contractors Association

I. SMACNA HVAC Duct Construction Standards, Latest Edition, for Metal and Flexible Ducts

J. U.L. - Underwriter's Laboratories

K. UL 555 - Standard for Safety; Fire Dampers

L. UL 555S - Standard for Safety; Leakage Rated Dampers for Use in Smoke Control Systems

1.5 SYSTEM DESCRIPTION

A. Design static pressure:
   1. 1 inch w.g. minimum for all low pressure ductwork applications.
   2. 3 inch w.g. minimum for all medium pressure ductwork applications.

1.6 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 01.
   2. Submit product data indicating typical catalog of information including arrangements.
   3. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication.
   4. Indicate mechanical and electrical service locations and requirements of equipment.
   5. Submit manufacturer's installation instructions.

B. Shop Drawings:
   1. Submit 1/4" per foot shop drawing(s) showing all ducts, piping and equipment shown by plans and specifications. Submit drawings on all mechanical rooms. The drawings shall be coordinated with structural and electrical. Provide sections for all congested areas and mechanical rooms. Submit prior to construction of ductwork.

1.7 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the quality as specified herein. All work shall comply with the Local Building Code, Mechanical Code, Fire Code, and all other applicable State and Local Codes or ordinances.

B. All equipment and materials shall be installed in a workmanlike manner by trained and experienced sheet metal technicians and mechanics as recommended by the manufacturers of the products installed.

C. All ductwork to be manufactured in accordance with SMACNA standards.

D. Where the standards and requirements of this specification exceed those of SMACNA, the requirements herein shall govern.

E. Except where specified otherwise, all sheet metal used shall be constructed from prime galvanized steel sheets or coils up to 60 inches in width. Each sheet shall be stenciled with manufacturer's name and gauge. Coils of sheet steel shall be stenciled throughout on 10 foot centers with manufacturer's name and gauge tolerances in inches.

F. Spiral pipe:
   1. All pipe and fittings must be from a single manufacturer.

G. Flexible:
   1. The composite assembly including insulation, vapor barrier, and glass scrim shall meet the Class 1 requirements of the latest NFPA Bulletin #90A and be labeled for a spread rating of 25 or less and a smoke development rating of 50 or under.

1.8 WARRANTY

A. Warranty all ductwork and dampers for 1 year from the date of final acceptance. The warranty will cover workmanship, noise, chatter, whistling, and vibration. Ductwork must be free from pulsation under all conditions of operation.

PART 2 PRODUCTS

2.1 RECTANGULAR AND ROUND RIGID DUCTS

A. Material:
   1. New, prime grade sheet or coil steel

B. Gauge:
   1. Select gauge in accordance with SMACNA Duct Construction Standards Tables 1-3 to 1-9 and Appendix- page 2.

C. Auditorium and stages:
   1. Increase two gauges (heavier) for the first 20 feet of supply and return duct.

D. Coating:
   1. Type:
      a. Continuous, hot-dip, galvanized coating

E. Application:
   1. 1-1/4 ounces per 1 square foot, two-sided sheet
   2. Comply with ASTM A 653.

F. Identification:
   1. Sheet steel:
      a. Stencil each sheet with manufacturer's name and gauge.

G. Coil steel:
   1. Stencil coils on 10 foot centers with manufacturer's name and gauge.

H. Construction:
   1. Manufacture in accordance with SMACNA Round Duct Standards, Tables 3-2A, 3-2B, and 3-3, Figures 3-1, 3-2, 3-3, 3-4, and 3-5.
   2. Pre-manufactured round duct may be used if approved by the Architect/Engineer.

2.2 EXHAUST DUCTS FOR TYPE I KITCHEN HOODS

A. Material:
1. Stainless steel - 18 ga. welded
2. Black steel - 16 ga. welded
3. Conform to NFPA 90A

B. Accessories:
1. Provide and install backdraft damper in kitchen hood exhaust ductwork.

C. Interlock:
1. Provide for automatic activation of all Type I kitchen hood exhaust fans by heat sensor(s) interlocked with the manual fan switch. Provide off delay relay set to run a minimum of y 5 minutes to prevent quick cycling and to clear the hood if heat remains after the fan is switched off. Provide temperature sensors in each hood section and space maximum 6'-0" O.C. Temperature sensors to be tested and set so that exhaust fan(s) activate not more than 15 minutes after the first appliance served by Type I hood has been turned on. Temperature sensor arrangements installed by the hood manufacturer are acceptable.

2.3 ACCESS DOORS

A. Install access doors to facilitate cleaning as required by code.

B. Install access doors as required for access to fire protection devices.

2.4 EXHAUST DUCTS FOR SHOWER ROOMS AND DISHWASHER DUCT SYSTEMS

A. Aluminum:
1. Gauge in accordance with SMACNA Standards.

2.5 EXHAUST DUCTS FOR FUME HOODS IN SCIENCE LABS

A. Materials:
1. Gauge in accordance with SMACNA standards.
2. Stainless steel - welded

2.6 DOUBLE - WALL INSULATED SPIRAL / RECTANGULAR DUCTWORK

A. Types:
1. Round
2. Flat Oval
3. Rectangular

B. Materials:
1. Duct: Sheet metal, select gauge in accordance with SMACNA Standards.
2. Solid Liner: Galvanized steel
3. Perforated: Galvanized steel
4. Insulation liner:
   a. 1-inch fiberglass with R-value greater than 4.0 for conditioned areas (gyms)
   b. 2-inch fiberglass with R-value greater than 5.0 inside building unconditioned space.
   c. 3-inch fiberglass with R value greater than 8.0 for exterior duct.

C. Conform to ASTM A653 and ASTM A924.

D. Conform to ASTM 463 for aluminized ductwork

E. Construction:
1. Double wall insulated
2. Spiral with lockseams
3. "Paint grip" finish on outer shell for exposed ductwork
4. Conform to ASTM A653
5. Fittings:
a. Spot welded and bonded construction
6. Outer joints:
a. Use flanged couplings that will withstand the maximum design pressure with no leakage.
7. Inner Liner Joints:
a. Use a separate slip coupling to connect the inner liner sections at duct to duct joints to allow for expansion/contraction.
b. Do not mechanically fix or seal inner lining couplings.

F. Flanged Joints:
1. Seal with a duct sealant that has a synthetic elastomeric base.
2. Sealant:
a. Formulated to withstand temperatures from -20 to 150 degrees F.
b. Formulated so that no surface preparation or solvent cleaning is necessary.
c. UL classified.

G. Control Dampers:
1. Construct with a 2 inch insulation layer and a solid inner liner.
2. Press stainless steel bearing sleeves into the frame of the outer shell to support the damper axle.
3. Extend the axle 6 inches from the outer shell body.
4. Attach a 1½ inch x 1½ inch reinforcement to the damper.

H. Elbow Radius:
1. 90-degree: 1-1/2 times duct diameter with 5 gores
2. 45-degree: 1-1/2 times duct diameter with 3 gores

I. Manufacturer/Model:
1. United McGill Corporation
2. Lewis & Lambert, LLP
3. Linx Industries
4. Precision Spiral Pipe
5. Spiral Pipe of Texas Corporation, Inc.

2.7 SINGLE - WALL, ROUND AND FLAT OVAL DUCT AND FITTINGS (FOR MEDIUM PRESSURE APPLICATION)

A. Medium Pressure (3-inch w.g.) rectangular duct not allowed.

B. Material:
1. New, prime grade sheet or coil steel.
a. Select gauge in accordance with SMACNA duct construction standards.

C. Fittings:
1. By Duct Manufacturer

D. Coatings:
1. Type:
a. Continuous, hot-dip galvanized coating.

E. Application:
   1. 1-1/4 ounces per 1 square foot, two-sided sheet.
   2. Comply with ASTM A653.

F. Identification:
   1. Sheet Steel
   2. Stencil each sheet with manufacturer's name and gauge.

G. Construction:
   1. Manufacture in accordance with SMACNA standards.

H. Approved Manufacturers:
   1. United McGill Corporation
   2. Lewis & Lambert, LLP
   3. Linx Industries
   4. Precision Spiral Pipe
   5. Spiral Pipe of Texas Corporation, Inc.

2.8 FLEXIBLE DUCTS

A. Material: In accordance with SMACNA Metal and Flexible Duct Standards, Latest Edition.

B. Construction:
   1. Factory insulate with high density fiberglass to a minimum R value of 5.79.
   2. Provide a positive interior air seal permanently bonded to a carbon steel spring helix.
   3. Sheath seal in a Class 1 vapor barrier and factory seal at both ends.
   4. Conform to U.L. 181, NFPA 90A

C. Manufacturer/Model:
   1. ATCO 30 Series

2.9 VOLUME CONTROL DAMPERS

A. Manufacturer:
   1. Nailor Industries Series 1020, 1021 or equal.

B. Type:
   1. Manually operated single blade or multi-blade
   2. Conform to SMACNA Duct Standards (Metal & Flexible), Figures 2-12 & 2-13.

C. Application:
   1. Provide in all branches, splits and taps whether indicated on plans or not.

D. Construction:
   1. Provide an indicating device with lock to hold damper in proper position.
   2. All manual dampers installed above hard ceilings or at other inaccessible areas shall be supplied with a cable operated damper equal to Young Regulator Model 830A-CC. Damper(s) to be opposed blade type constructed of .050 minimum heavy duty extruded aluminum frames and blades. All necessary hardware to ensure compatibility with remote cable control system shall be included. Damper blades to include individual blade bushings for smooth and quiet operation. Damper blades shall rotate between a matched pair of formed and punched 306 stainless steel connecting slide rails which facilitate smooth blade movement and ensure alignment.

2.10 TURNING VANES

A. Provide in all rectangular supply elbows. Turning vanes in return air ductwork is not necessary.

B. Conform to SMACNA Duct Standards, Figures 2-3 and 2-4.

2.11 DUCT SEALANT

A. Equal to Glenkote "Seal-Flex" duct sealer, Hardcast "Irongrip 601", Foster 32-19" or "Childers CP-146"

2.12 FIRE DAMPERS

A. Manufacturer/Model:
   1. Fire Dampers - Pottorff, Ruskin, Greenheck, National Controlled Air or Nailor
   2. Ceiling Fire Dampers/Thermal Blankets - CK-2000-1 thermal blanket and Model CFSR-2 ceiling damper for supply outlets (round or square) and CFSR-2 for return outlets (square).

B. Type:
   1. 212ºF fusible link fire damper.
   2. Fire protection rating: 1.5 hours
   3. Conform to UL Standard 555 and be UL labeled
   4. Tested in accordance with AMCA 500.

C. Application:
   1. Provide at locations shown on plans and where required by Local and State ordinances.

D. Features:
   1. Maximum leakage 8 cfm at 4-inch S.P.
   2. Vertical or horizontal installation
   3. Radiation blanket
   4. Blades 16 gauge galvanized, maximum 6-inch width.
   5. 5 year warranty.

E. Manufacturer/Model:
   1. Ceiling Fire Dampers:
      a. Pottorff Ceiling Fire Dampers/Thermal Blankets - Series CFD
      b. Equals by Nailor Industries, NCA, United Air, Ruskin, Greenheck

2.13 DUCT SILENCERS / SOUND ATTENUATORS

A. Manufacturers:
   1. Price
   2. IAC Acoustics
   3. Kinetics Noise Control
   4. McGill Airflow LLC.
   5. Ruskin Co.
   6. Vibro-Acoustics

B. Rectangular Silencer Outer Casing:
   1. ASTM A 653/A 653M, G90 Galvanized sheet steel, 0.034 inch thick.

C. Inner Casing and Baffles:
   1. ASTM A 653/ A 653M, G90 Galvanized sheet metal, 0.034 inch thick, with 1/8-inch diameter perforations.

D. Connection size: Match connecting ductwork, unless otherwise noted.

E. Sound Absorbing Mechanism:
   1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
   2. Dissipative type with fill media
      a. Fill material - inert and vermin-proof fibrous material, packed under moisture-proof non-fibrous material.
      b. Erosion barrier - polymer bag enclosing fill, heat sealed before assembly.

F. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or react to system pressure variations. Do not use mechanical fasteners for unit assemblies. Units shall be completely factory fabricated. No field assembly required.

2.14 SMOKE DAMPERS

A. Manufacturer/Model:
   1. Pottorff Model SD Series to have 120 VAC 'fail-safe' operation motor. Motor normally energized, any power interruption to activate damper to the closed position.
   2. Equals by Nailor Industries, Air Balance, Inc., United Air

B. Type:
   1. Resettable smoke dampers.
   2. Leakage rated, no fire protection rating required
   3. Conform to UL Standard 555S, Leakage Class I
   4. UL labeled.
   5. Tested in accordance with AMCA-500, AMCA 511

C. Application:
   1. Provide at locations shown on plans and where required by Local and State ordinances.
   2. All smoke/fire dampers under 16” in height shall be oversized and transitioned down to duct size to maximize free area. Where it is impossible to oversize duct/openings, then a flat top and bottom frame style shall be used.

D. Features:
   1. Resettable thermostat 212°F control point with 120 volt AC Belimo motor.
   2. 120 VAC motor
   3. Vertical or horizontal installation
   4. Radiation blanket
   5. Maximum leakage to be 8 CFM at 4-inch S.P.
   6. Interface with fire alarm
   7. Blades 16 gauge galvanized, maximum 6-inch width.
   8. 5 year warranty.

2.15 COMBINATION FIRE / SMOKE DAMPERS

A. Manufacturer/Model:
   1. Pottorff Model FSD Series to have 120 VAC 'fail-safe' operation motor. Motor normally energized, any power interruption to activate damper to the closed position.
   2. Pottorff Ceiling Fire Dampers/Thermal Blankets - Series CFD Pottorff, Ruskin, or Greenheck.
   3. Equals by Nailor Industries, Air Balance, Inc., United Air

B. Type:
   1. Resettable combination fire/smoke dampers.
   2. Fire protection rating: 1.5 hours
   3. Conform to UL Standard 555S, Class II-250°F
   4. UL labeled
   5. Tested in accordance with AMCA-500, AMCA 511

C. Application:
   1. Provide at locations shown on plans and where required by Local and State ordinances.
   2. All smoke/fire dampers under 16” in height shall be oversized and transitioned down to duct size to maximize free area. Where it is impossible to oversize duct/openings, then a flat top and bottom frame style shall be used.

D. Features:
   1. Resettable thermostat 212° F control point with 120 volt AC Belimo motor.
   2. 120 VAC motor
   3. Vertical or horizontal installation
   4. Radiation blanket
   5. Maximum leakage to be 8 CFM at 4-inch S.P.
   6. Interface with fire alarm
   7. Blades 16 gauge galvanized, maximum 6-inch width.
   8. 5 year warranty.

2.16 GRILLE AND DIFFUSER

A. Pottorff Model CFD 3-hour.

B. Match dampers with rating to grilles and diffusers.

2.17 FIRE SAFETY FUNCTIONS FOR BUILDINGS WITH EXISTING FIRE ALARM SYSTEM- DUCT MOUNTED SMOKE DETECTORS, CONTROL RELAYS, AND SMOKE FIRE DAMPER CONTROL

A. At minimum, duct mounted smoke detectors required on all air handlers, fan coil units, fan powered boxes and packaged rooftop units rated at 2000 CFM or more.

B. The Mechanical Contractor shall employ a Fire Alarm sub-contractor that is licensed by the State of Texas Fire Marshal and a factory authorized distributor for the brand of existing fire alarm system to provide the devices and perform the final low-voltage hook-up. Duct mounted smoke detector housings and sample tubes shall be furnished by the Fire Alarm sub-contractor and mounted by the Mechanical Contractor. Line voltage hook-up shall be by the Electrical Contractor.

C. Fire Alarm Safety Control Functions, which may include the operation of fire alarm Control Relays [CR] associated with duct mounted smoke detector [D]/air handler shut down, high volume low speed (HVLS) fan shut down, fire door hold-back and release, smoke fire damper motor control, et cetera, shall be initiated via Control Relays which shall be de-energized under fire alarm conditions. These Control Relays shall be provided and mounted by the Fire Alarm Contractor and located within three feet of the unit. These Control Relays shall be controlled by a fail-safe Fire Safety Control Function circuit. For each controlled device the contractor providing the device shall wire it internally for fail-safe shut-down and provide a labeled 3' coil of cable outside the unit to allow the fire alarm contractor to make final connection to the Common and N.O. or N.C. dry contacts on the fire alarm SPDT Control Relay. Each Fire Safety Control Function circuit controlled device shall be configured such that when the fire alarm system safety control circuit is re-energized, by the fire alarm control panel, the device

shall return to normal operation (e.g. be ready to re-start) without a need for manual or environmental control system intervention.

D. Duct mounted smoke detector housings with addressable or conventional photoelectric detector heads (to match the existing fire alarm system) shall be provided where shown on the drawings, or as required. Detectors shall operate by the photoelectric light-scattering principal using an LED light source to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. The detector shall operate in air velocities of 300 to 4,000 ft./min. without a shift in sensitivity. Each detector shall be resettable form the FACP.

E. The unit shall include a 16-gauge steel or Noryl molded plastic enclosure with molded integral conduit knockouts. The unit shall be provided with gasket seals to provide proper sealing of housing to mechanical ductwork and to insure proper airflow into the detector sampling chamber. Duct housing shall be designed for mounting to rectangular or round ducts.

F. Each duct mounted detector housing shall be labeled in a visible area with its device hardware address or zone utilizing self-laminating, flexible vinyl film, non-smear, machine printed labels.

G. The Duct Detector Unit shall be UL listed to the most current UL 268A standard and be cross-listed for use with the fire alarm control panel. Each duct unit shall be equipped with sampling tubes protruding into the associated ductwork. For ducts up to 3' wide, the supply tube shall be 1" shorter than the duct width. For ducts 3' to 8' wide the sampling tube to be 1" longer than the duct width and protrude through the opposite side of the duct for support. Duct widths greater than 8' will require internal bracing. Sampling tubes shall be configured to provide adequate airflow through the detector housing and fitted with an integral porosity filter system to aid in reducing detector contamination. Detectors shall be installed per NFPA 90A and the manufacturer's instructions.

H. When smoke is detected by a duct mounted smoke detector, it shall activate a supervisory fire alarm condition at the fire alarm control panel. Duct mounted smoke detectors shall indicate a supervisory alarm unless otherwise directed, duct mounted smoke detectors are not a substitute for area detection. In either case, the activation of any duct mounted smoke detector shall actuate all related fire alarm safety control functions.

I. Each smoke detector shall be attached to a SLC and set to a distinct address and internal identification code, which the control panel shall use to identify the location, status, and type of device. Duct detectors must be powered from the fire alarm system.

J. Each detector shall be provided with a remote power/status LED. The remote LED indicator shall be located in the nearest corridor ceiling unless otherwise directed. The status LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. The LED shall be placed into steady illumination when a supervisory condition has been detected.

K. Each remote LED faceplate shall have an engraved plastic nameplate permanently attached indicating the HVAC unit number, type, and device identification number as programmed in panel. Labels shall be 1/16" thick two ply black/white acrylic sheet engraving stock with all sides beveled.

L. Each HVAC unit for which a Duct mounted Smoke detector is installed shall also have a blower shutdown relay as listed below.

M. Provide housing with base and photoelectric detector head, sampling tube, and remote LED.

N. Fire Safety Function HVAC Unit Blower Shut-Down and Smoke Fire Damper Operation:
   1. Provide a power relay for each fire safety control circuit as required to operate smoke fire dampers, control relays for shut-down of each air handler, et cetera, as indicated on plans.

O. Fire Safety Function Control Module:
   1. Addressable Control/Relay Modules shall be provided where required to provide NAC interface or relay controlled fire alarm functions. The control module will mount in a standard 4-inch electrical box. The control module shall provide a dry contact (form C) relay with SPDT dry contacts rated at 2.0 amps @ 24 VDC and 0.5 Amps @ 120 VAC (pilot duty).

P. Power to operate the relay actuation shall be provided by the SLC. Each control module shall be operated by events as programmed in the control panel (i.e. operate on alarm condition). Control modules shall feature status LEDs to indicate the module is operational and when the relay is energized.

Q. Each control module shall be set to a distinct address and internal identification code on the SLC, which the control panel shall use to identify the location, status, and type of device.

R. Each control module shall have an engraved plastic nameplate permanently attached indicating the devices function and control panel device identification number. Labels shall be 1/16" thick two ply black/white acrylic sheet engraving stock with all sides beveled.

S. Fire Safety Function Power Relay:
   1. Power Relays shall be provided as required to control each fire safety control functions circuit, one or two circuits may be controlled by each relay. Each relay shall be operated by a 120 VAC coil and feature DPDT dry contacts rated 30 Amps @ 120 VAC. Each relay shall be mounted in a surface mount metal enclosure with conduit knockouts. Relays shall be UL recognized and rated for ten million mechanical operations.
   2. Air Products & Controls model MR-199X-14/C, 120 VAC coil, heavy duty power relay with metal enclosure or approved equivalent.

T. Fire Safety Function Control Relays:
   1. Control Relays shall be provided where a relay control interface is required to perform fire safety control functions; air handler shut-down, fire door control, et cetera. Each relay shall be operated by a multi-voltage coil (24 VDC, 24 VAC, or 120 VAC), feature SPDT dry contacts rated 10 Amps @ 120 VAC, and a status LED to indicate the relay is energized. Each relay shall be mounted in a surface mount metal enclosure with a status LED viewing hole and conduit knockouts. Relays shall be UL recognized and rated for ten million mechanical operations.
   2. Air Products & Controls model MR-101/C, multi-voltage coil, control relay with metal enclosure or approved equivalent.

2.18 FIRE SAFETY FUNCTIONS FOR BUILDINGS WITH NO FIRE ALARM SYSTEM - DUCT MOUNTED SMOKE DETECTORS, CONTROL RELAYS, AND SMOKE FIRE DAMPER CONTROL

A. At minimum, duct mounted smoke detectors required on all air handlers, fan coil units, fan powered boxes and packaged rooftop units rated at 2000 CFM or more.

B. The Mechanical Contractor shall furnish and install standalone duct mounted smoke detectors, housings, and sample tubes in accordance with the manufacturer’s instructions.

C. Line voltage hook-up shall be by the Electrical Contractor.

D. The HVAC Control System Contractor shall wire the stand alone duct mounted smoke detector auxiliary contacts for each individual air handler so that the control circuit will de-energize when an alarm condition is detected. The HVAC Control System shall not bypass or replace this shut-down function. The HVAC Control System shall be configured such that when the stand alone duct mounted smoke detector is manually reset, the unit shall return to normal operation (e.g. start running again) without intervention of the control system.

E. The Duct Detector Unit shall be UL listed to the most current UL 268A standard and be cross-listed for use with the fire alarm control panel. Each duct unit shall be equipped with sampling tubes protruding into the associated ductwork. For ducts up to 3' wide, the supply tube shall be 1" shorter than the duct width. For ducts 3' to 8' wide the sampling tube to be 1" longer than the duct width and protrude through the opposite side of the duct for support. Duct widths greater than 8' will require internal bracing. Sampling tubes shall be configured to provide adequate airflow through the detector housing and fitted with an integral porosity filter system to aid in reducing detector contamination. Detectors shall be installed per NFPA 90A and the manufacturer's instructions.

F. Manufacturer/Model:
   1. System Sensor DH100ACDCLP, or equivalent, 4-wire photoelectric duct detector with low-flow technology with ST-x Series sampling tube, width as required. Unit power input terminals to accept 24 VDC, 24 VAC 50-60 HZ, 120 VAC 50-60 HZ, or 220/240 VAC 50-60 HZ. Unit to feature two alarm auxiliary contacts for fan shutdown, etc. rated at 10A @ 30 VDC resistive, 10A @ 250 VAC, or 100 mA minimum @ 5 VDC. Utilize auxiliary contacts for air handler shut-down and when required to operate smoke fire dampers as indicated on plans.
   2. Each duct mounted detector housing shall be labeled in a visible area indicating the HVAC unit number, type, and location identification utilizing self-laminating, flexible vinyl film, non-smear, machine printed labels.
   3. For each duct mounted smoke detector, furnish one System Sensor SSK451, or equivalent, Multi-Signaling Accessory with Key-activated test/reset functions and sounder horn. Device shall feature status LEDs for Power (green), Trouble (amber) and Alarm (red). Unit shall be suitable for wall or ceiling mount in a double-gang standard electrical box. Mount Multi-Signaling Accessory device in the nearest corridor ceiling or on wall at 8’-0” A.F.F. where no ceiling or high ceilings exist.
   4. Each remote Multi-Signaling Accessory faceplate shall have an engraved plastic nameplate permanently attached indicating the HVAC unit number, type, and location identification. Labels shall be 1/16" thick two ply black/white acrylic sheet engraving stock with all sides beveled.

G. Acceptable Manufacturers:
   1. Air Products & Controls
   2. BRK
   3. Pittway
   4. System Sensor

PART 3 EXECUTION

3.1 INSTALLATION

A. Erect all ductwork in the general locations shown.

B. Conform to all structural and finish conditions of the building.

C. Ductwork shall not be allowed to pass through or over designated electrical rooms.

D. Before fabricating any ductwork, check the physical conditions at the job site and make all necessary changes in cross sections, offsets, and similar items, whether they are specifically indicated or not.

E. Where ductwork is shown to be lined on the inside with duct liner, the sizes shown on the plans are the inside dimensions. Therefore, sheet metal dimensions shall be increased accordingly.

F. Seal all joints both transverse and longitudinal seams, with duct sealant in accordance with Table 1-2 Class B.

G. Install 1" roll type filter media on all return duct openings prior to starting blowers. Leave in place and change as necessary during construction.

H. Before installing grilles, operate air conditioning unit fans and remove all debris or foreign matter.

I. Rectangular ductwork:
   1. Construct in accordance with SMACNA, Duct Construction Standards for the specific duct pressure classification involved (see pressure classification). Do not use radius ells with square throats.

J. Round ductwork:
   1. Connect with slip type joints using a minimum of three sheet metal screws per joint and in accordance with SMACNA Duct Construction Standards.

K. Flexible ductwork:
   1. All flexible ducts shall be demountable and individual lengths shall not be in excess of seven feet. Flexible ducts are not allowed to substitute rectangular return air ductwork, unless approved by engineer.
   2. Use only factory-made connectors.
   3. Flexible ducts should be installed fully extended, free of sags and kinks.

L. Kitchen Hood Exhaust Ductwork:
   1. Provide a liquid tight continuous external weld or braze on all seams and joints in the ductwork. Weld to be made on the external surface of the duct system.
   2. All horizontal ductwork to be sloped in accordance with NFPA #96 - 7.1.4. A minimum 2 percent slope for ductwork up to 75'-0". A minimum 8 percent slope for ductwork over 75'-0".
   3. Provide grease duct reservoir below all horizontal ductwork. Must comply with the following:
      a. Extend across full width of the ductwork with a length not less than 12 inches.
      b. Have a minimum depth of 1 inch.
      c. Must slope to a drain.
      d. Must be provided with a cleanout opening located on the side or on top of the duct to provide direct access to the reservoir to permit cleaning of the reservoir.
   4. Sections of grease ducts that are inaccessible from the hood or discharge openings shall be provided with cleanout openings spaced not more than 10'-0" from any change in direction greater than 45 degrees.
   5. Cleanouts and openings shall be equipped with liquid tight doors constructed of steel having thickness not less than that required for that duct.

6. Prior to the use or concealment of any portion of a grease duct system, a leakage test shall be performed. Ducts shall be considered concealed where installed in shafts or covered by coatings, wraps, or insulation that prevents the ductwork from being visually inspected on all sides. The permit holder shall be responsible to provide the necessary equipment al perform the grease duct leakage test. A light test shall be performed to determine that all welded and brazed joints are liquid tight.

M. Science Lab and Fume Hood Exhaust Ducts:
1. Provide a liquid tight continuous external weld on all seams and joints in the ductwork.
2. Provide access doors to duct and shaft.
3. Fume hood exhaust ductwork shall not pass through any fire rated wall.

N. Dishwasher and Shower Room Exhaust Ductwork:
1. Provide dishwasher and shower room with aluminum or stainless steel exhaust ductwork as specified for standard duct construction for sheet metal ductwork.
2. Make all joints in the bottom of horizontal runs watertight.
3. Slope horizontal runs to exhaust grille.
4. Use unlined duct in all dishwasher and shower room installations.

O. Double-wall insulated spiral/rectangular ductwork:
1. Install without exposed insulation in all exposed ceiling areas.
2. Provide ductwork installation that is high quality, very neat, and aesthetically pleasing.
3. The final appearance of the ductwork shall be approved by the Architect/Engineer.

P. Exterior Ductwork:
1. Install so that water sheds off of ductwork and is weathertight.

Q. Reinforcement:
1. Reinforce all ducts to prevent buckling, breathing, vibration, or unnecessary noise.
2. Reinforcing shall be in accordance with SMACNA Duct Construction Standards (Metal and Flexible), Tables 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, and 1-9 plus any additional reinforcing to meet job conditions.
3. All ducts shall be supported in accordance with SMACNA Duct Construction Standards (Metal and Flexible), Tables 4-1, 4-2, 4-3.

R. Flexible Connections:
1. Where ducts connect to fans or air handling units, make flexible airtight connections using "Ventglas" fabric.
2. The fabric must be fire-resistant, waterproof and mildew resistant with a weight of approximately 30 ounces per square yard.
3. Provide a minimum of 1/2 inch slack in the connections, and a minimum of 2-1/2 inches distance between the edges of the ducts.
4. Provide a minimum of 1 inch slack for each inch of static pressure on the fan system.
5. Securely fasten fabric to apparatus and to adjacent ductwork by means of galvanized flats or draw bands.
6. Do not install outdoors, except where detailed on plans.
7. Where connections are made in outdoor locations, seal fabric to metal with mastic.

S. Access Doors:
1. Install ductwork access doors in structural angle frames and provide with sash locks and hinges arranged for convenient access.
2. Construct doors which occur in insulated ducts with an insulation filler.
3. All access doors shall be appropriately labeled.

T. Flashing and Opening Sealing:
   1. Ducts passing through roofs or exterior walls:
      a. Provide suitable flashing to prevent rain or air currents from entering the building as detailed on plans.
      b. The flashing shall be minimum No. 24 gauge galvanized steel.

U. Ducts passing through mezzanine walls:
   1. Completely seal the penetration with acoustic sealant and fill all gaps between the ductwork and the wall materials.
   2. Sealant must be capable of preventing sound from exiting the mechanical rooms through these openings.

V. Ducts penetrating the floor:
   1. Make the entire penetration watertight by installing appropriate flashing and/or application of G.E. silicone sealant.
   2. The penetration must be capable of maintaining standing water in the mechanical area without allowing any water through the opening.

W. Duct Leakage:
   1. Seal ductwork in accordance with Table 1-2 of the SMACNA HVAC Duct Construction Standards - Metal and Flexible.
   2. Minimal leakage is expected for ductwork constructed to these standards but in no case shall the total leakage exceed 1% of designed CFM.
   3. All joints to be sealed with duct sealant.

X. Fire and Smoke Dampers:
   1. Install fire and smoke dampers at locations shown on plans, and where required by local and state ordinances.
   2. Do not compress or stretch SFD, FD frame into duct or opening.
   3. Install dampers square and free from racking with blade running horizontally.
   4. Handle damper suing sleeve or frame. Do not lift damper using blades actuator, or jackshaft.
   5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.
   6. Provide access doors in attached ductwork for inspection.
   7. Stencil each door "Fire Damper Access" per U. L. 555 standard.
   8. Install fire dampers in openings utilizing steel angles, sleeves, and other materials, and practices required to provide an installation equivalent that used by manufacturer when dampers were tested at UL.
   9. Install in accordance with damper manufacturer's published recommendations and instructions and NFPA Standard 90A.

3.2 BALANCING DAMPERS

A. Volume Control Dampers:
   1. Install manually operated volume control dampers in all branch ducts, splits or taps whether indicated on the drawings or not. Install a minimum of 5’-0” from grille/diffuser.
   2. Provide indicating device with lock to hold damper in position.

B. Cable Operated Dampers:
   1. Install a minimum of 5’-0” from grille/diffuser.
   2. Install to facilitate smooth blade movement and ensure alignment.

C. Back Draft Dampers:
   1. Install back draft dampers as shown on plans.
   2. Manufacturer: Nailor Industries Series 1300 or equal.

D. Air Intake Ducts:
   1. Insulate all outside air intake ducts.

3.3 DAMPER IDENTIFICATION

A. Provide a securely attached red band and a label reading "Damper Location" at the location of all concealed manual dampers.

B. All manual dampers which are not readily visible after duct insulation installation shall be identified in this manner.

3.4 DUCTWORK SUPPORT

A. All ducting must be supported from building structure.

B. Duct straps are not allowed to be screwed to roof decks, support from cross bridging or supported from bottom chord of joists.

C. Do not support from roof or floor deck joist bridging.

D. Support sizes and spacing shall conform to SMACNA Standards.

END OF SECTION

SECTION 23 33 33

ACCESS DOORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Access doors and their installation requirements.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

C. Section 23 09 23 - Energy Management Control System

D. Section 23 21 13 - Hydronic Piping, Valves, and Appurtenances

E. Section 23 31 13 - Metal Ductwork

1.4 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acudor

B. Elmdor

C. Mifab

2.2 ACCESS DOORS

A. Locations requiring access doors:
   1. Concealed valves
   2. Traps
   3. Trap primers
   4. Controls
   5. Cleanouts
   6. Dampers
   7. Ducts adjacent to fire doors, fire dampers, and smoke detectors.
   8. Equipment above hard ceilings.
   9. Other equipment requiring accessibility for operation and maintenance.

B. Type:
   1. Hinged flush-type steel framed door with straps and exposed narrow border.

C. Minimum size:
   1. 18" x 18" unless otherwise indicated.
   2. 24” x 24” for equipment above hard ceilings.
   3. Conform to architectural panel pattern for acoustical ceilings.
   4. Confirm size with Building Inspector and Engineer.

D. Construction:
   1. Hinges: Concealed continuous type.
   2. Locking Device: Flush cam type, screw driver operated.

E. Fire Rating:
   1. Same or better fire rating than the surrounding area.

F. Access doors located in kitchens, restrooms or areas where water is present shall be stainless steel.

2.3 FACTORY PAINTING

A. Apply prime coat of rust inhibiting paint, unless located in wet area.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations.

B. In suspended acoustical ceilings, provide a beaded pin or other approved means for identification and easy removal where necessary.

C. Access doors shall only be installed in areas/locations that are readily accessible.

D. Doors shall be installed in such a manner that door will open 180 degrees.

END OF SECTION

SECTION 23 34 16

HVAC FANS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Centrifugal fans

B. Axial fans

C. Propeller fans

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

C. Section 23 31 13 - Metal Ductwork

D. Section 23 37 13 - Diffusers, Registers and Grilles

1.4 REFERENCES

A. AMCA - Air Moving and Conditioning Association, Inc.

B. UL - Underwriter's Laboratory

1.5 QUALITY ASSURANCE

A. UL Listed and Bear Label

B. Tested in accordance with AMCA standards

1.6 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

B. Submit product data indicating typical catalog data, including arrangements, dimensions, general assembly, and materials used in fabrication.

C. Provide in table form a schedule similar to drawings with data listing all fans, information, accessories, etc.

D. Indicate mechanical and electrical service locations and requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acme

B. Cook

C. Greenheck

D. CaptiveAire

E. PennBarry

F. Twin City Fans

2.2 GENERAL

A. Provide fan type, arrangement, capacity, size, motor horsepower, and motor voltage as shown on the drawings.

B. Rate fans according to appropriate Air Moving and Conditioning Association, Inc. (AMCA) approved test codes and procedures. Seal to be attached.

C. Supply fans with sound ratings below the maximums permitted by AMCA standards.

D. All fans provided must bear the UL Label.

E. Sound levels shall be as listed or quieter. Fans with excessive noise will be replaced at Contractor's expense.

F. Fans are to be supplied with engraved aluminum nameplates indicating CFM, static pressure, manufacturer, serial number, and model number.

2.3 ROOF MOUNTED EXHAUST FANS

A. Type:
   1. Roof mounted, direct driven centrifugal exhaust ventilator. Fan shall be spun aluminum and mounted on vibration isolators.

B. Motors:
   1. NEMA design B with a minimum of Class B insulation rated for continuous duty and furnished at the scheduled voltage.
   2. Motor shall be electronically commutated motor rated for continuous duty and furnished either with internally mounted potentiometer speed controller, or with leads for connection to 0-10 VDC external controller.
   3. Exhaust fan motor to be located outside of the exhaust airstream and enclosed in a weather-tight compartment.

C. Mounting:
   1. Resilient mounts outside the air stream.

D. Cooling:
   1. Forced air cooling.

E. Bearing Rating:
   1. Heavy duty regreasable ball type in a cast iron pillowblock housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.

F. Construction:
1. Fan shall be bolted and welded construction utilizing corrosion resistant fasteners.
2. Spun aluminum structural components shall be constructed of minimum 18 gauge marine alloy aluminum, and bolted to a rigid aluminum support structure.
3. Aluminum base shall have continuously welded curb cap corners for maximum leak protection.
4. Fan wheel shall be backward inclined, constructed of 100% aluminum, and provided with an aerodynamic aluminum inlet cone.
5. Integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections.
6. Provide 1/2 inch galvanized mesh bird screen over openings

G. Features:
1. switch and motor to the junction box
2. Automatic dampers with curb flanges
3. Insulated, prefabricated curb with cant strips and with resilient gasket on top flange.
4. Minimum 18 gauge galvanized steel or aluminum.
5. Factory installed variable speed controller.
6. Minimum 18 inch curb height.
7. Lifting lugs.

H. Verify roof slope so that fans are installed in a level condition.

I. Coordinate and furnish curbs that are compatible with roof being installed.

2.4 CEILING MOUNTED EXHAUST FANS

A. Type:
1. Centrifugal, direct driven exhaust fans

B. Motors:
1. Motor shall be totally enclosed type with permanently lubricated bearings and built-in thermal overload protection.

C. Construction:
1. Fan housing shall be minimum 20 gauge galvanized steel and acoustically insulated.
2. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel.
3. Fan wheels shall be twin DWDI centrifugal forward curved type, constructed of galvanized steel.
4. Integral aluminum backdraft damper.

D. Features:
1. Disconnect switch: Internal wiring box with switch.
2. Blower assembly to be easily removed without disconnecting the ductwork.
3. Factory tested prior to shipment.
4. Powder painted white steel grille.
5. Factory installed variable speed controller.
6. Provide 277 volt to 120 volt transformer.

2.5 PROPELLER WALL FANS

A. Type:
1. Belt driven fan with heavy duty stamped steel propellers.

B. Propeller:
   1. Propeller to consist of 6 blades securely attached to a heavy gauge steel spider by means of steel rivets and to be heavily reinforced on each side.
   2. The stamped propeller to be the same manufacturer as the fan.

C. Construction:
   1. Constructed of heavy gauge painted steel.
   2. Fan assembly bolted to the venturi.
   3. Fan bearings: Heavy duty regreasable ball type in a cast iron pillowblock housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.

D. Motor:
   1. Permanently lubricated with built-in overloads.
   2. Mounting: Resilient mounts
   3. Cooling: Forced air cooling

E. Features:
   1. Aluminum shutter
   2. Aluminum or steel box
   3. Motor guard
   4. Factory installed automatic belt tensioner (to maintain proper belt tension).
   5. Adjustable anchor angle to adjust for wall thickness
   6. Ball guard

2.6 KITCHEN SUPPLY FANS

A. Type:
   1. Roof mounted centrifugal forward curve fans, belt drive, mounted on vibration isolators.

B. Motor:
   1. Permanently lubricated with built-in thermal overloads.
   2. Mounting: Resilient mounts.
   3. Cooling: Forced air cooling.

C. Construction:
   1. Hoods, housings and bases: galvanized steel, insulated, easy removable cover.
   2. Rainproof

D. Filters:
   1. Permanent, 1" thick
   2. Washable
   3. Aluminum

E. Features:
   1. Disconnect switch: Internal wiring box with switch.
   2. Blower assembly to be easily removed without disconnecting the ductwork.
   3. Factory tested prior to shipment.

2.7 KITCHEN EXHAUST FANS

A. Type:
   1. Roof mounted, upblast centrifugal exhaust ventilator. Fan shall be spun aluminum and mounted on vibration isolators.

B. Motor:
   1. NEMA design B with a minimum of Class B insulation rated for continuous duty and furnished at the scheduled voltage.
   2. Motor shall be electronically commutated motor rated for continuous duty and furnished either with internally mounted potentiometer speed controller, or with leads for connection to 0-10 VDC external controller.
   3. Exhaust fan motor to be located outside of the exhaust airstream.

C. Mounting:
   1. Resilient mounts.

D. Cooling:
   1. Forced air cooling.

E. Bearing Rating:
   1. Heavy duty regreasable ball type in a cast iron pillowblock housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.

F. Construction:
   1. Spun aluminum cover and inlet cone. Minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure.
   2. Aluminum base shall have a one piece inlet spinning and continuously welded curb cap corner for maximum leak protection.
   3. Centrifugal, backward inclined wheel, aluminum construction. Wheel inlet shall overlap an aerodynamic aluminum inlet cone. Wheel to be non-overloading static and dynamically balanced.
   4. Stainless steel quick release latches to provide access into the motor compartment without the use of tools.
   5. External wiring compartment with integral conduit chase shall be provided into the motor compartment to facilitate wiring connections.

G. Features:
   1. Disconnect switch: Internal wiring box with switch.
   2. Blower assembly to be easily removed without disconnecting the ductwork.
   3. Factory tested prior to shipment.
   4. Vented extension roof curb (minimum 8”).
   5. Hinged base.
   6. Lifting lugs.
   7. Grease trough.

2.8 SUPPLEMENTAL EQUIPMENT

A. Weatherproof motor covers for outdoor installations:
   1. Apply the same finish as used on the fan.

B. Belt driven fans:
   1. Equip the fan motors with variable pitch sheaves. Select the sheave size for the approximate midpoint of adjustment and to provide not less than 20 percent speed variation from full open to full closed.

C. Nonadjustable motor sheaves:
   1. Use for motor sizes over 15 horsepower.

D. Factory wired, safety disconnect switch on each unit.

E. Heaters with starters.

F. Internal overload protection circuit.

2.9 PROTECTIVE COATINGS

A. Apply manufacturer's standard prime coat and finish to all fans, motors and accessories, except on aluminum surfaces or where special coatings are required.

B. Galvanizing:
   1. Hot dip coat all surfaces which require galvanizing.
   2. Where galvanizing is specified, a zinc coating may be used.
   3. After fabrication, apply the zinc coating and air dry the coating to 95 percent pure zinc.
      a. Zinc Coatings:
         (1) Amercoat
         (2) Diametcoat
         (3) Sealube
         (4) Zincilate

C. All exhaust fans which will operate in a corrosive environment (Science Labs, etc.) shall have a factory applied acid resistant coating.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install fans according to the manufacturer's instructions and in the locations shown on the drawings.

B. **All roof mounted fans shall have electrical wiring and conduit internal to roof curb and fan housing. No external wiring or conduit will be allowed on roof.**

C. Verify compliance of “in Situ” vibration readings with AMCA Standard 204-05.

D. All fans shall be air balanced in accordance with Section 23 05 93.

E. Top of level curb to have minimum 11” from finished roof to top of curb.

F. Screw fans to curbs with gasketed screws.

3.2 START-UP

A. Start fans to verify rotation and operation sequence prior to test and balance.

3.3 IDENTIFICATION

A. Provide identification per Section 23 05 53.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Grilles

B. Diffusers

C. Registers

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

C. Section 23 31 13 - Metal Ductwork

D. Section 23 34 16 - HVAC Fans

1.4 REFERENCES

A. ARI Standard 890-94 Rating of Air Diffusers and Air Assembles.

1.5 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

B. Product data for review prior to placement of purchase order:
   1. Outlets
   2. Grilles
   3. Registers
   4. Control devices
   5. Diffusers
   6. Similar equipment

C. Product data shall be submitted for each device specified. Data shall be arranged to match grille schedule.

D. If a manufacturer other than the one scheduled on the plan is used, the sizes shown on the plans shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made.

E. Selections shall meet the manufacturer's own published data for the above performance criteria.

F. If grilles other than those scheduled by name are furnished, manufacturer shall be prepared to demonstrate compliance with noise criteria at Engineer's request and to Engineer's satisfaction.

1.6 COORDINATION

A. Coordinate this work with work under Division 26 to insure that intended functions of lighting and air systems are achieved.

B. Locations of outlets on plans are approximate and shall be coordinated with other trades to make symmetrical patterns.

C. Locations shall be governed by the established pattern of the lighting fixtures or architectural reflected ceiling plan.

D. The Contractor shall move any grille, register, or outlet up to four feet in any direction as directed by the Engineer at no additional cost.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide grilles, registers and diffusers as shown or scheduled on the plans. Conform to ARI 890-94.

B. All air distribution devices in kitchen and any wet areas such as locker rooms, showers and restrooms shall be 100% aluminum construction.

C. All air distribution devices for 1-hour structures (walls or ceilings) shall be steel construction conforming to all codes and standards.

2.2 MANUFACTURERS

A. Metalaire

B. Krueger

C. Titus

D. Nailor

E. Price

F. Greenheck

G. Pottorff

H. United Enertech

2.3 PERFORMANCE CRITERIA

A. Throw: Velocity at the end of the throw, in the 5’-0” occupancy zone, will be between 25 to 50 FPM.

B. Noise levels (NC Curve):
   1. Not to exceed those scheduled below.
      a. Classrooms, Libraries, and Offices - 25 N.C.
      b. Cafeterias - 30 N.C.
      c. Gymnasiums - 40 N.C.

C. All devices shall be tested per Air Diffusion Council and labeled as such.

2.4 FINISHES

A. Paint exposed devices with factory standard prime coat or factory finish coat. Architect/ Engineer to determine final color of grille.

PART 3 EXECUTION

3.1 INSTALLATION

A. Where called for on the schedules, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual dampers. These shall be the standard product of the manufacturer, subject to review by the Engineer.

B. All ceiling devices shall be furnished to be compatible with the ceilings in which they are installed.

END OF SECTION

SECTION 23 43 23

BIPOLAR IONIZATION AIR PURIFICATION SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 DESCRIPTION OF WORK

A. This section describes the design, performance and installation of a bipolar ionization air purification system intended for use on the project. Ionization units shall be supplied to provide between 500 and 1500 negative ions per cubic centimeter in the areas served.

B. Where the air purification system is intended to reduce outside ventilation air in accordance with the International Mechanical Code and ASHRAE 62.1, the manufacturer shall provide calculations to justify such reduction.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

C. Section 23 31 13 - Metal Ductwork

D. Section 23 37 13 - Diffusers, Registers, and Grilles

1.4 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

B. Submit product data indicating typical catalog data, including arrangements, dimensions, general assembly, and materials used in fabrication.

C. Provide in table form a schedule similar to drawings with data listing all units, information, accessories, etc.

D. Indicate mechanical and electrical service locations and requirements.

1.5 QUALITY ASSURANCE

A. The air purification system shall be a product of an established manufacturer with a minimum of 10 outside air reduction installations in successful operation in the USA. Technologies that do not operate through a gas disassociation process like UV lights, powered particulate filters, and/or polarized media filters, will not be considered.

B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.

C. The air purification system products shall be tested and listed by UL and ETL according to UL Standard 2998 - Electrostatic Air Cleaners. Air purification system products shall specifically be tested and passed UL 2043 to ensure plenum rating.

D. The operation of bi-polar ionization units shall conform to UL 867 with respect to ozone generation.

E. The manufacturer must submit Indoor Air Quality calculations to confirm acceptable indoor conditions at the scheduled air flows in accordance with ASHRAE Standard 62.1. The calculations shall be independently validated to verify accuracy of the IAQ calculations and conformance with Standard 62.1 by third party testing on a previous installation.

1.6 RELATED WORK PERTAINING TO OTHER SPECIFICATIONS

A. Electrical wiring

B. Ductwork

1.7 REFERENCE CODES AND STANDARDS

A. UL Standard 2998 and Standard 2043

B. National Electric Code NFPA 70

C. ASHRAE Standard 62.1

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Plasma Air International

B. Bioclimatic

C. Phenomenal Air

D. Air Oasis

E. Other qualified manufacturer's meeting the requirements of this specification may be submitted for approval 10 business days prior to bid date.

2.2 PERFORMANCE CRITERIA

A. The bipolar ionization system shall operate and be a zero ozone product.

B. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a plasma ion generator with bipolar ionization output as described here within.

C. The Bi-polar Ionization system shall be capable of:
1. Effectively neutralizing microorganisms downstream of the bipolar ionization equipment (mold, bacteria, virus, etc.).
2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
3. Reducing space static charges.

4. Reducing space particle counts.
5. When mounted to the air entering side of a cooling coil, keep the coil free from pathogen and mold growth.
6. All manufacturers shall provide documentation by an independent accredited laboratory that proves the product has minimum neutralized rates for the following pathogens given the allotted time and in space conditions.
    a. MRSA - 99.75% in 30 minutes
    b. Influenza Virus (H1N1) - 80.5% in 30 minutes, 86.6% in 60 minutes
    c. E. Coli - 99.43 % in 120 minutes
    d. Cladosporium Cladosporiodes - 97.7% in 120 minutes
    e. Aspergillus Niger - 97.1% in 120 minutes
    f. Staphylococcus Aureus - 81.7% in 120 minutes
7. Manufacturers not providing the equivalent space neutralized rates shall not be acceptable. All manufacturers requesting prior approval shall provide to the engineer independent test data from an accredited independent lab confirming the neutralized rates and time per the above.

D. The bipolar ionization system shall operate in such a manner that equal amounts of positive and negative ions are produced. Single pole ion devices shall not be acceptable.
1. Airflow rates may vary through the full operating range of a VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.
2. Velocity Profile: The air purification device shall not have a maximum velocity profile.

E. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions to the air purification system.

2.3 EQUIPMENT REQUIREMENTS

A. Electrode Specifications (Bi-polar Ionization):
1. Each plasma generator with bipolar ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. Bipolar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, and performance output reduction over time.
2. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.
3. Ionization output from each electrode shall be a minimum of 5 million ions/cc when tested at 2” from the ion generator.
4. Manufacturer shall demonstrate that no voltage potential exists due to exposed electrical components in the duct system or plenum. Exposed needles protruding into the air steam will not be accepted.

B. Air Handler mounted units
1. Where so indicated on the plans and/or schedules, Plasma generators shall be supplied and installed. Ion generators for air handling units shall be furnished in a linear or rack mounted configuration so as to minimize the space required for installation. Ionization "rack" shall be no more than 3" deep in the direction of airflow.
2. The mechanical contractor shall mount the plasma ionization rack and wire it to the remote mount power supply panel using only low voltage wiring. Low voltage wiring shall be defined as 12V. The use of line voltage (120V or 230V) or high voltage cabling (600V or higher) shall not be acceptable due to safety concerns.
3. The remote mount power supply panel shall be capable of accepting voltage ratings of 12V DC, 24V AC, 120V AC or 230V AC. The panel shall have an on/off switch, power indicator LED, and a set of dry contacts which will indicate ionizer functionality. Dry contacts that indicate power available only shall not be acceptable.

C. Duct mounted units
   1. Where so indicated on the plans and/or schedules, plasma ion generators shall be supplied and installed by the mechanical contractor. The contractor shall follow all manufacturer IOM instructions during installation.
   2. Ion generators shall be furnished with a factory-equipped gasketed mounting flange to prevent air leakage. Gasketed flange shall be a minimum of 1 1/8" wide around the perimeter of the ionizer to insure no leakage occurs.
   3. Ion generators shall be field installed in a location that is convenient for visual inspection, removal, and servicing. They shall include an ion indicator light clearly visible from below the installed location.
   4. Ion generators shall be wired from the 24V AC fan and common terminal of the control power circuit. Ion generators shall be capable of directly accepting 24V AC power. The use of loose step down transformers or power converters shall not be acceptable.

2.4 ELECTRICAL AND CONTROL REQUIREMENTS

A. Ion generators shall contain a built-in power supply and operate on 24V AC and shall connect to the fan and common terminals of the fan coil unit or air handling unit served. Ion generators requiring a loose 24V, 120V or 230V transformer or power supply will not be accepted.

B. Wiring, conduit and junction boxes shall be furnished and installed by the electrical contractor within housing plenums and shall be UL and NEC NFPA 70 approved.

C. All plasma ion generators shall include internal short circuit protection, overload protection, and automatic fault reset. Overload protection and associated automatic fault reset shall occur internally to the unit and be performed through circuitry on the unit's PCB. Manual fuse replacement and manual fault reset of each unit shall not be accepted.

D. All plasma ion generators shall include an external BMS interface to indicate ion generator status and alarm. Light emitting diode shall be visible from the ground for each unit and shall be on any time power is on to the unit and ions are being generated. Light signaling unit power only shall not be acceptable.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Ionization units shall be installed per manufacturer's installation instructions and requirements.

3.2 ASSEMBLY AND INSTALLATION

A. Assemble ionization units and install in supply ductwork downstream of all coils and upstream of the first supply tap. Ionization units are not to be installed in return air ductwork.

B. Ionization units to be installed inside unit cabinet. No screws or penetrations will be allowed to attach inside unit. The preferred mounting location is upstream of the fan inlet, downstream from unit particle filter(s) and upstream of unit’s cooling coil.

C. Electrical contractor shall complete single point power connections.

D. Protect equipment from water and damage before and after installation.

3.3 COMMISSIONING AND TRAINING

A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

B. Provide 5 copies of Operating and Maintenance Manuals.

C. OPTIONAL ADD FOR HANDHELD ION COUNTER: Provide to the owner a portable hand held ion counter with a calibrated range of 0 to 20,000 ions/cm3 and an accuracy of +/- 25% within the specified range. Ion counter shall have automatic zeroing capability on 10 minute intervals.

3.4 WARRANTY

A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of twelve months after shipment or eighteen months from owner acceptance, whichever occurs first. Labor to replace equipment under warranty shall be provided by the installing contractor

END OF SECTION

SECTION 23 52 33

WATER TUBE BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Natural gas-fired hot water boilers for use in providing hot water for space heating.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 19 - Meters and Gauges for HVAC Piping

C. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

D. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

E. Section 23 09 23 - Energy Management Control System

F. Section 23 21 13 - Hydronic Piping, Valves, and Appurtenances

G. Section 23 21 23 - Hydronic Pumps

1.4 REFERENCES

A. Texas Department of Labor Boiler Rules and Regulations.

B. AGA - American Gas Association

C. GAMA - Gas Appliance Manufacturers Association

D. ASME - The American Society of Mechanical Engineers

E. NFPA - National Fire Protection Association

F. ANSI - American National Standards Institute

G. Texas Boiler Law

1.5 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 00, General Conditions, and Division 01.
   2. Submit product data indicating typical catalog of information including arrangements.
   3. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication.

4. Indicate mechanical and electrical service locations and requirements.
5. Submit manufacturer's installation instructions.

B. Shop Drawings:
1. Submit 1/4" per foot shop drawing(s) showing all ducts, piping, and equipment shown by plans and specifications. Submit drawings on all mechanical rooms. The drawings shall be coordinated with structural and electrical. Provide sections for all congested areas and mechanical rooms.

1.6 WARRANTY

A. Heat Exchanger:
1. 10 year limited warranty against failure caused by defective workmanship or material.

PART 2 - PRODUCTS

2.1 MANUFACTURER/MODEL:

A. Lochinvar

B. Aerco

C. Larrs

2.2 TYPE

A. Natural Gas Fired
1. Material
a. 16-gauge jacket material.
b. Galvanized inside and outside.
c. Protect with a 3-coat acrylic enamel finish.

B. Meet performance criteria listed on the plans.

C. National Board listed for 160 psi working pressure.

D. AGA listed and approved.

E. ASME "H" stamped.

F. Test certified at 84% thermal efficiency.

G. Minimum 4:1 turndown

H. Factory assembled, pre-wired and tested.

I. Boiler manufacturer to provide primary pump for low temperature bypass piping system.

2.3 WATER-CONTAINING SECTIONS

A. Material
1. Copper

B. Construction
1. Fin-tube construction using straight, solid copper tubes.

2. Extruded integral fins spaced at 7 fins per inch.
3. Tubes to be set horizontal and rolled securely into glass-coated cast iron headers. The tubes shall terminate into a one piece, lined, cast iron header. There shall be no bolts, gaskets or "O" rings in the header configuration.

2.4 HEAT EXCHANGER

A. Construction
1. Horizontal, two-pass configuration. Gasket-less.
2. Completely enclose the combustion chamber for maximum efficiency.

2.5 COMBUSTION CHAMBERS

A. Type
1. Sealed combustion type employing "power burner" concept.

B. Burner:
1. The combustion chamber shall be sealed and completely enclosed with ceramic fiberboard insulation.
2. The burner shall have an integral blower to precisely control the Fuel/Air mixture for maximum efficiency.
3. Pre-purge cycle: "Cleans" the combustion chambers prior to ignition upon a call for heat.

2.6 STANDARD OPERATING CONTROLS

A. Glow-plug ignition device.

B. Operating aquastat.

C. Electric high-limit switch.

D. Automatic main gas valve.

E. Redundant gas valve.

F. Main gas pressure regulator.

G. Master switch with pilot light.

H. ASME pressure relief valve.

I. Temperature gauges.

2.7 OPERATION MONITORING

A. External viewing ports
1. Permits visual observation of burner operation.

B. Low NOx Requirements
1. All boilers shall meet the TNRCC requirements for low NOx emissions as follows:
a. ≤ 75 MBTU 55 PPM
b. > 75 ≤ 400 MBTU 55 PPM
c. >400 MBTU 30 PPM

C. Boilers/water heaters not meeting these standards will be rejected.

2.8 THREE WAY MIXING VALVE:

A. Provide and install low temperature mixing valve at the inlet/ bypass of each boiler.

2.9 FLUE:

A. Provide type, category, and size per manufacturer with stainless inner liner.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install at the locations shown and in accordance with the details provided on the plans and in these specifications.

B. Provide a factory start up report by the boiler supplier. Startup report shall be made and delivered to the mechanical engineer and the test and balance agency. The following items shall be noted and recorded. Temperature settings for each stage, high limit temperature, inlet water temperature, outlet water temperature, temperature difference (Delta T), gas pressure (Inches WC), unit on, unit off, type of gas, manifold gas pressures at each gas valve, air pressure at combustion air blower, type of venting, draft readings, supply water settings, and name of reporting person.

C. Equipment Mounting:
   1. Install boilers on cast-in-place 4” concrete equipment base.

D. Install gas-fired boilers according to NFPA 54, ANSI Z223.

E. Assemble and install boiler trim.

F. Install electrical devices furnished with boiler but not specified to be factory mounted.

G. Install control wiring to field mounted electrical devices.

H. Hardwire interlock each boiler to carbon monoxide (CO) sensor.

3.2 CONNECTIONS:

A. Piping
   1. Each boiler shall be provided with all necessary inlet and outlet connections. Refer to specific Boiler’s specification sheet for connection sizes.
   2. Check Manufacturer’s Installation Manual for clearance dimensions and install piping that will allow for service and ease of maintenance.
   3. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection and adhere to proper codes.

END OF SECTION

SECTION 23 64 23

AIR COOLED SCROLL COMPRESSOR CHILLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Packaged, Air-Cooled Scroll Compressor Liquid Chillers.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 19 - Meters and Gauges for HVAC Piping

C. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

D. Section 23 09 23 - Energy Management Control System

E. Section 23 21 13 - Hydronic Piping, Valves, and Appurtenances

F. Section 23 21 23 - Hydronic Pumps

1.4 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

B. Submit shop drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate valves, strainers, vents, and thermostatic valves required for complete system.

C. Submit product data indicating rated capacities, weights, specialties and accessories, electrical requirements, and wiring diagrams.

1.5 REFERENCES

A. ANSI/AHRI 550/590 - Performance Rating of Water Chilling and Heat Pump Water Heating Packages using the Vapor Compression Cycle.

B. ANSI/ASHRAE 15-2019 - Safety Code for Mechanical Refrigeration.

C. ASHRAE 90.1-2016 - Energy Conservation in New Building Design.

D. ASME SEC 8 - Boiler and Pressure Vessel Code.

E. NEMA MG 1 - Motors and Generators.

F. UL 1995 - Standard for Heating and Cooling Equipment, second edition.

G. ARI 370 - Standard for Sound Rating of Large Outdoor Refrigerating and Air-conditioning Equipment

1.6 OPERATION AND MAINTENANCE DATA

A. Include manufacturer's descriptive literature, start- up instructions, and maintenance procedures.

1.7 REGULATORY REQUIREMENTS

A. Comply with ANSI/AHRI 550/590 - Performance Rating of Water Chilling and Heat Pump Water Heating Packages using the Vapor Compression Cycle.

B. Unit shall conform to UL 1995/CSA 22.2 #236 for construction of air cooled chiller and shall have UL/CSA label affixed to unit.
   1. In the event the unit is not UL/CSA approved, the manufacturer shall, at his expense, provide for a field inspection by a UL/CSA representative to verify conformance to UL/CSA standards. If necessary, contractor shall perform required modifications to the unit to comply with UL/CSA, as directed by the UL/CSA representative, at no additional expense to the Owner.

C. Conform to ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of reciprocating water chillers.

D. Conform to ANSI/ASHRAE Standard 15-2019 for construction and operation of water chillers.

1.8 ACOUSTICS

A. Manufacturer shall provide outdoor sound power level data across all major octave band center frequencies for cataloged operating range of unit at gross cooling capacity range. Data shall be obtained in conformance with ANSI S1.32-1980, American National Standard Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow Band Noise Sources in Reverberation Rooms and per AMCA Standard 300-85 test code "Sound Rating Air Moving Devices".

1.9 HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.10 WARRANTY

A. Provide a full unit parts and labor warranty, including refrigerant. Warranty shall be for a period of 66 months from shipment, or 60 months from start up, whichever occurs first.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Daikin

B. York

C. Carrier

2.2 SUMMARY

A. The contractor shall furnish and install air-cooled water chillers as shown as scheduled on the contract documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

2.3 GENERAL UNIT DESCRIPTION

A. Provide factory assembled and tested outdoor air- cooled chillers consisting compressors, condenser, evaporator, thermal expansion valve, refrigeration accessories, and control panel. Reciprocating compressors are not acceptable. Construction and ratings shall be in accordance with ANSI/AHRI 590. The chiller short circuit withstand rating shall be at least as large as the AIC rating of the electrical panel feeding it (PROVIDED ON SCHEDULE), unless noted otherwise.

2.4 SCROLL COMPRESSORS

A. Compressors shall be industrial grade, energy efficient direct drive 3600 RPM maximum speed scroll type. The motor shall be of a suction gas cooled hermetic design. Compressor shall have centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve. A solid state temperature sensor shall be embedded in the motor windings to protect against excessive winding temperatures.

B. Motor shall be designed for across-the-line starting and suitable for a voltage utilization range of +/- 10 percent from nameplate voltage.

C. Provide crankcase heater to evaporate refrigerant returning to crankcase during shut down. Energize heater when compressor is not operating.

2.5 EVAPORATOR

A. Provide plate and frame type evaporator with welded steel construction. Each plate and frame shall be provided with a drain and vent connection.

B. Design, test, and stamp refrigerant side for 225 psig working pressure. Water side shall be designed for 300 psig working pressure.

C. Insulate with 0.75 inch thick flexible elastomeric rubber, closed cell insulation with maximum K value of 0.26. Provide thermostatically controlled heat tape to protect evaporator to 0°F.

D. Provide Thermal Dispersion type flow sensor equal to IFM Effector.

2.6 CONDENSERS

A. Construct condenser coils of aluminum fins mechanically bonded to copper tubing. Provide sub-cooling circuits. Factory leak test under water to 450 psig. All aluminum condenser coils (micro channel) are acceptable.

B. Provide vertical discharge direct drive propeller type condenser fans with fan guard on discharge. Equip with permanently lubricated ball bearings and three-phase thermal overload protection.

C. Provide low ambient operation to allow the unit to start and operate down to 0°F outdoor ambient conditions. VFD controlled condenser fans shall be modulated based upon refrigerant head pressure.

D. Provide factory mounted, full length, louvered hail guards, steel panels to protect the condenser coils, wiring, sensors and piping. The panels shall cover all the condenser coils and all refrigeration components. Coordinate with owner/ engineer if owner prefers to leave bottom of chiller open for ease of maintenance.

2.7 ENCLOSURES

A. House components in 12-14 gauge welded galvanized steel frame with minimum 16 gauge galvanized steel panels and weather resistant access doors, phosphatized and finished with air dry paint.

B. Unit paint finish shall be capable of withstanding over 600 consecutive hours of salt spray resistance in accordance with ASTM B117 test method.

2.8 REFRIGERANT CIRCUIT AND CAPACITY MODULATION

A. Provide refrigerant circuits with full operating charge of refrigerant and oil completely piped and factory leak tested.

B. Provide for each refrigerant circuit:
   1. Liquid line solenoid valve.
   2. Filter dryer.
   3. Liquid line sight glass and moisture indicator.
   4. Thermal expansion valve.
   5. Charging valve.
   6. Liquid line shut-off valve.
   7. Compressor discharge service valve.

C. Capacity Modulation:
   1. Provide scroll compressor chillers with a minimum four step capacity control in response to leaving chilled water temperature. Leaving chilled water temperature control range shall be 40-60°F (adjustable).

2.9 CONTROLS

A. Provide unit mounted weatherproof steel control panel, containing power and control wiring, field-provided disconnect switch for factory wired with single point power connection (verify with electrical). Each unit control panel shall have compressor contactors and unit controller. Standard power connections include main three phase power and integral controls transformer that handles the unit controls and unit freeze protection. The unit controller shall be suitable to control leaving chilled solution temperature for selectable comfort or process applications, automatic compressor sequencing, load limiting and anti-recycle functions. Failure protections include loss of chilled water flow, chiller freeze protection, chilled water flow interlock, head pressure control, pump down control, low ambient start, hot start control and low ambient lockout. Leaving and entering solution temperature sensor is factory installed. Controls include auto/stop switch, a leaving water temperature setpoint adjustment, a Delta T adjustment viewable through the unit Human Interface digital display. **Chiller disconnect to be rated at 65k AIC.**

B. Provide microprocessor controller with the following failure controls with display:
   1. Loss of chilled water flow.
   2. High/Low refrigerant pressure switch(s).
   3. Oil pressure switch.
   4. Loss of refrigerant charge.

5. High motor winding temperature.
6. Low temperature thermostat operation.

C. Provide the following operating controls:
1. Leaving chilled water temperature control.
2. Timer prevents compressor from short cycling.
3. Periodic pump down.
4. Load limit thermostat.
5. Low ambient control consisting of VFD controlled condenser fans, controls head pressure for operation down to 0°F
6. Hot gas bypass sized for minimum compressor loading.
7. Chilled water set point.

2.10 ENERGY MANAGEMENT SYSTEM

A. The chiller shall be provided with the necessary hardware to allow the building automation system to enable and disable each chiller. Additionally, the chilled water temperature setpoint shall be controlled via the building automation system. The current limit setting shall be controllable from the building automation system. Provide chiller with BACnet communications interface to relay exact alarms and up to 35 operating parameters to the building's energy management control system.

2.11 MISCELLANEOUS FEATURES

A. Provide lead-lag function that either by mechanical or microprocessor devices alternates the usage of compressors.

B. Compressor motor overloads capable of monitoring compressor motor current. Provides extra protection against compressor reverse rotation, phase loss, and phase imbalance.

C. Provide interface module that will allow generic automation systems interface through 0-5 VDC or 0-10 VDC signals.

D. Provide flow switch for field installation to indicate loss of evaporator flow. Flow switch to be thermal dispersion type. Equal to IFM Effector.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Align chiller package on steel or concrete foundations.

C. For ground mounted application, chiller manufacturer to provide neoprene pads beneath all chiller support footings. For roof mounted applications, chiller manufacturer to provide spring isolation devices beneath all chiller support footings.

D. Verify power requirements and connect to electrical service.

E. Connect to chilled water piping. On inlet, provide thermometer well for temperature controller, thermometer well for temperature limit controller, and shut- off valve. On outlet, provide flexible pipe connector and shut-off valve.

3.2 MANUFACTURER'S FIELD SERVICES

A. Supply service of factory trained representative for a minimum period of two (2) days to supervise testing, start- up, and instruction on operation and maintenance to Owner.

B. Provide manufacturer's service capabilities no more than 50 miles from installation.

3.3 REGULATORY REQUIREMENTS:

A. Conform to AHRI 590 Standard for testing and rating of Positive Displacement Compressor Water - Chilling Packages.

B. Conform to ANSI/UL 465 code for construction of water chillers and provide UL label. In the event the unit is not UL approved, the manufacturer shall, at his expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative.

C. Conform to ANSI/ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of water chillers.

D. Conform to ANSI/ASHRAE 15 code for construction and operation of water chillers.

3.4 STORAGE AND HANDLING:

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units, to be performed by the successful contractor.

B. Protect units from physical damage. Factory coil shipping covers shall be kept in place until installation.

C. Unit controls shall be capable of withstanding 203°F (95°C) storage temperatures in the control compartment for an indefinite period of time.

3.5 START-UP SUPERVISION AND WARRANTY:

A. The manufacturer shall provide start-up supervision and operator training of the air cooled chiller. The contractor shall verify that all required electrical, controls and piping is properly connected and operational. The manufacturer shall clearly state in his bid that the start-up supervision and training will be performed by a factory trained representative, not sales personnel.

B. The manufacturer shall provide a full unit parts and labor warranty, including refrigerant. Warranty shall be for a period of 66 months from shipment, or 60 months from start up, whichever occurs first. This warranty shall not be provided by the mechanical contractor. The manufacturer shall state on his submittal and operation and maintenance manuals that this warranty is provided by the manufacturer.

END OF SECTION

SECTION 23 73 13

MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Packaged indoor central station air handling units.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

C. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

D. Section 23 09 23 - Energy Management Control System

E. Section 23 21 13 - Hydronic Piping, Valves and Appurtenances

F. Section 23 23 00 - Refrigerant Piping

G. Section 23 31 13 - Metal Ductwork

1.4 REFERENCES

A. AHRI 430 - Standard for Central Station Air Handling Units.

B. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

C. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

D. SMACNA - HVAC Duct Construction Standards.

E. AHRI 410 - Standard for Forced Circulation Air-Cooling and Air-Heating Coils.

F. ANSI/UL 900 - Test Performance of Air Filter Units.

G. AMCA 300 - Reverberant Method for Sound Testing of Fans.

H. ARI 260P - Method for Rating Air Handling Units for Sound.

I. AMCA 301 - Method for Publishing Sound Ratings for Air Moving Devices.

J. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.

K. NEC - National Electric Code

1.5 QUALITY ASSURANCE

A. Unit will conform to AMCA 210 for fan performance ratings.

B. Unit will conform to E.T.L. standards. Unit will be ETL listed.

C. Unit sound ratings will be reported in accordance with AHRI 260 for inlet and discharge sound power levels.

D. Unit casing radiated sound ratings will be reported in accordance with ISO 9614 parts 1 and 2, and ANSI S12.12.

E. Unit will conform to AHRI 410 for capacities, pressure drops, and selection procedures of air coils.

F. Unit will conform to ANSI/ AHRI 430 for all fabrication procedures of air handling units.

G. Damper performance will comply with AMCA 500

H. Air handling unit will be ISO 9001 certified.

I. Air handling unit will be manufactured in an ISO 9002 certified facility.

1.6 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 1.

B. Submit unit performance including: capacity, nominal and operating performance, fan curves with fan operating point clearly marked.

C. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

D. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations. Indicate unit shipping, installation and operating weights including dimensions.

E. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.

F. Submit sound power levels by octave band for air handling units at scheduled design conditions. Provide sound power levels for "discharge", "inlet plus cabinet" and “casing radiated” sound paths in accordance with AMCA 300 and AMCA 301. If unit sound power levels exceed values of the scheduled units on drawings, whether the sound power levels are scheduled or not, the contractor shall submit detailed plan outlining steps to meet design noise levels. Comply with ARI-260P and ASHRAE 68.

G. The contractor shall provide a 1/4" scale drawing of the mechanical equipment rooms where all air handling units will be located. The drawing shall show all piping, equipment and required maintenance clearances for the equipment. This drawing shall be furnished prior to commencement of work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of the contract documents. Units shall ship fully

assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Each section shall have lifting lugs or shipping skid to allow for field rigging and final placement of section.

B. Deliver units to site with fan motors completely assembled and mounted in units. Mount motors as specified in these contract documents.

C. Store and protect products under provisions of the contract documents.

D. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. The contractor shall be responsible for the repair of the units if any damage occurs due to improper storage and handling. The contractor shall protect the units with tarpaulins, not plastic covering. Indoor units shall ship from the factory shrink-wrapped. Outdoor units shall have coverings protected and weatherproof.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.10 EXTRA FILTERS

A. Provide two (2) sets of unit filters. One set, minimum, shall be utilized during the construction phase of the project. During the construction phase of the project the contractor shall maintain clean filters in the unit. The construction filters shall be replaced at time of owner acceptance of substantial completion.

1.11 WARRANTY

A. Unit manufacturer shall warrant unit and factory packaged controls for eighteen (18) months from date of shipments or twelve (12) months from manufacturer supervised on-site start-up.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Carrier

B. Aaon

C. Daikin

D. Trane

E. York

F. Temtrol

2.2 GENERAL

A. Manufacturer must clearly define any exceptions made to Plans and Specifications. Mechanical Contractor is responsible for expenses that occur due to exceptions made.

B. Unit will be complete with fan(s), motors, coils, dampers, access doors and other components/ options as described and scheduled on drawings.

C. Factory fabricate air handling units of dimensions, capacities, and configurations as scheduled and shown on drawings. Any deviations in physical dimensions are the contractor's responsibility to verify. All manufacturer clearances must be maintained.

D. Provide formed or welded structural steel base rails shall be installed around entire perimeter or unit to support all sections.

E. Unit will be draw through type configuration.

F. Fans and drives will be balanced to limit vibration at operating speeds.

G. The general contractor shall provide a concrete housekeeping pad for all units located on the floor. The concrete housekeeping pad shall be tall enough to provide proper trapping of the air handling unit. The concrete pad height shall have a minimum height of 4".

H. Lifting lugs will be provided where required for proper lifting.

I. If shown on plans or schedule, provide an 18" access door between all coils for cleaning and inspection.

2.3 UNIT CASING

A. Unit shall be constructed of a complete structural frame with removable panels. Removal of side panels shall not affect the structural integrity of the unit. Contractor shall be responsible to provide connection flanges and all other framework that is needed on unit to ensure that removal of unit's panels shall not affect structural integrity.

B. Panels shall be fully removable to allow for a proper way to thoroughly clean panels of microbial growth and to access internal parts. If panels are not removable, then manufacturer shall provide access sections with doors between all internal components to ensure access and cleanability of the air handler.

C. Unit casing will be factory insulated with spray injected foam to achieve a minimum thermal resistance of R-13. Insulation application will meet the requirements of NFPA 90A. Insulation system will be resistant to mold growth in accordance with UL 181 or ASTM C 1338. Unit shall have subfloor.

D. Unit will conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1% of design airflow at 8" of total static pressure.

E. Unit will have double wall, 2" insulated panels for walls, roof, and floor. Exterior casing will be galvanized steel.

F. Wall panels and access doors will deflect no more than L/240 when subjected to 8" of total static pressure. Floor panels will be double wall construction, designed to provide at most L/240 deflection when subjected to a 300lb. point load at mid span.

G. Casing shall have full size removable access doors. Access doors shall have double wall construction. Provide automotive style neoprene gasketing around full perimeter of access doors to prevent air leakage. Provide "ventlock" style non-corrosive alloy latches operable from the inside or outside of unit. If access doors open against unit operating pressure, provide safety latches that allow access doors to partially open after first handle movement and fully open after second handle movement.

H. Double wall insulated access doors will be provided. Access doors will be of the same material type as exterior/ interior casing.

I. All view ports will be double-pane UV resistant tempered glass.

2.4 DRAIN PAN CONSTRUCTION

A. Provide sealed double wall insulated drain pans constructed of galvanized steel exterior panels and stainless steel interior liner.
   1. Coil supports and bulkheads shall be 304 Stainless Steel
   2. Encase insulation between exterior and interior walls.
   3. Drain pans shall be double sloped at least 1/8" per foot and have no horizontal surfaces.
   4. Drain pans shall drain to one point.
   5. Drain connections shall be welded to drain pans.
   6. Drain pans shall have at least 1" clearance between pan and coil supports.

2.5 FAN SECTION

A. Units shall be provided with the fan configurations (Quantity) shown in the schedule. Units provided with fewer fans will not be acceptable.

B. The Fan Wall System, as manufactured by CES Inc., shall consist of multiple, direct driven, arrangement plenum fans constructed per AMCA requirements for the duty specified. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The Fan Wall Array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include an 11 gauge, A60 Galvanized steel intake wall, 14 gauge spun steel inlet funnel, and an 11 gauge G90 Galvanized steel motor support plate and structure. The fan intake wall, inlet funnel, and motor support structure shall be powder coated for superior corrosion resistance. All motors shall be high efficiency pedestal mounted type, T-frame motors selected at the specified operating voltage and RPM, as specified or as scheduled elsewhere. All motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.

C. The FWT array shall be provided with acoustical silencers that reduce the bare fan discharge sound power levels by a minimum of 15 db re 10^-12 watts throughout the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same unit without the silencers. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the Air Handling Unit when compared to the same FWT unit without the silencer array.

D. The fan array shall consist of multiple fan and motor "cubes", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel

cross section and components contained therein. Each fan cube shall be individually wired to a motor overload control panel for a connection to a single VFD, as specified elsewhere, for the total connected HP for all fan motors contained in the FWT array. Panel shall have individual motor overloads for each motor. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards.

E. The Fan Wall array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the Fan Wall array intake plenum wall, and at a distance of 48" from the discharge side of the Fan Wall intake plenum wall.

F. Each fan/motor assembly shall be removable through a 30" wide, free area, access door located on the discharge side of the fan wall array.

G. The unit must be provided with a close-off plate to cover a fan cube upon failure. Back-draft dampers are not acceptable. Provide fans with zero net effect vertical backdraft dampers. These non-controlled dampers shall provide for isolation in event a fan fails or is turned off. Ruskin type or weighted backdraft dampers are not acceptable.

H. The manufacturer shall have at least two years of experience in the fabrication and installation of fan wall arrays.

I. Motors greater than 10 HP must have 1 motor removal rail per row of fans.

J. TEFC, TEAO or ECM motors only. ODP motors not allowed.

K. Motors shall be 1800 rpm or 3500 rpm (900 rpm and 1200 rpm motors are not acceptable). Motors using VFD's shall comply with the requirements of NEMA MG 1 part 31 section 31.40.4.2 for peak voltage withstand capability.

Motor HP	Full Load Nominal Efficiency	3/4 Load Efficiency	2/4 Load Efficiency
3	88.5	88.5	87.5
5	89.5	89.5	89.2
7-1/2	90.2	91.0	90.8

2.6 COILS

A. Water coils, direct expansion (DX) coils, and steam coils shall have capacity and pressure drop performance certified in accordance with AHRI Standard 410.

B. Maximum face velocity across coils shall be 490 fpm.

C. Coils shall be manufactured by the same company as the supplier of the air handling unit. Install coils such that headers and return bends are fully enclosed by unit casings.

D. Coils shall have aluminum fins and seamless copper tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of tubes. Do not use soldering or tinning in bonding process.

E. Construct coil casings of 304 stainless steel with formed end supports and top and bottom channels.

F. Coils will be removable from the side of the unit via removable air handling unit panel. No more than one panel must be removed in order to remove coil.

G. Water Coils:
1. Clearly label supply and return headers on outside of units such that direction of coil water-flow is counter to direction of unit airflow.
2. Coils shall be proof tested to 300 psig and leak tested under water to 200 psig air pressure.
3. Construct headers of round copper pipe or cast iron.
4. Construct tubes of 1/2 inch O.D. minimum 0.016 inch thick copper and construct fins of aluminum.
5. If two or more coils are stacked in unit, install intermediate drain channels between coils to drain condensate to main drain pans without flooding lower coils or passing condensate through airstream.

H. DX Coils:
1. Clearly label suction and discharge headers on outside of unit.
2. Coils shall be proof tested to 450 psig and leak tested under water to 300 psig air pressure.
3. After testing, the inside of the coils shall be dried, all connections shall be sealed, and the coil shall be shipped with a charge of dry nitrogen.
4. Suction headers shall be constructed of copper tubing with connections penetrating unit casing to permit sweat connections to refrigerant lines.
5. Construct tubes of 1/2 inch O.D. minimum 0.016 inch thick copper and construct fins of aluminum.
6. If two or more coils are stacked in unit, install intermediate drain channels between coils to drain condensate to main drain pans without flooding lower coils or passing condensate through airstream.

2.7 ELECTRIC HEAT SECTION

A. Provide electric heating coils as scheduled. For pre-heat applications, coil shall be constructed with open-coil type A resistance elements, 80% nickel, 20% chromium. Type C alloys containing iron or other alloys are not acceptable.

B. Heaters shall be furnished with a disc type, automatic reset thermal cutout for primary over temperature protection. Heaters shall also be furnished with disc type, load carrying manual reset thermal cutouts, factory wired in series with heater stages for secondary protection. Heater limiters or other fusible over temperature devices are not acceptable.

C. Heaters shall be rated for the voltage, phase and number of heating stages indicated on the schedule. All three-phase heaters shall have equal, balanced, three-phase stages.

D. Electric heater shall be factory wired to an electronic step controller relay bank. This type of control may be connected to a 0-10VDC or 4-20mA signal from a standalone thermostat or building automation system, which is converted to stages of heat.

E. Terminal blocks shall be provided for all field wiring and shall be sized for installation of 75 degree C copper wire rated in accordance with NEC table 310-16, not more than three conductors in a conduit.

2.8 GAS HEAT SECTION

A. The gas heat section construction shall match the rest of the air handling unit and be an integral part of the air handling unit.

B. Indirect fired gas heaters shall be completely factory assembled, piped, and operationally fire tested at the factory prior to shipment.

C. Heat exchanger primary drum and secondary tubes shall be constructed of 14 gauge, 409 stainless steel. Industrial burner shall be UL listed, force draft, and fully modulating.

D. The entire gas heating section shall bear a UL label for Commercial-Industrial Gas Heating Equipment (ANSI/ UL Standard 795) and Industrial Gas-Fired Package Furnaces (CGA Standard 3.2-1976).

2.9 COMBINATION FILTER/MIXING BOX WITH FILTERS

A. Provide factory fabricated filter/mixing box section of the same construction and finish as unit casings. Filter sections shall have filter guides and full height, double wall, hinged, removable access doors for filter removal. Provide filter blockoffs as required to prevent air bypass around filters.

B. Provide 2-inch filter sections with pleated media MERV 8 filters. Filters shall be removable from one side of filter sections. The contractor shall replace the construction filters whenever they are dirty and replaced with clean filters, prior to occupancy.

C. Dampers shall modulate the volume of outdoor, return, or exhaust air. The dampers shall be of double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on all blades. The blades shall rotate on stainless steel sleeve bearings. Provide internally mounted low leak outside air and return air dampers. Construct damper blades and damper frames of galvanized steel. Leakage rate shall not exceed 4 CFM/square foot at 1-inch w.g. and comply with ASHRAE 90.1 maximum damper leakage.

PART 3 EXECUTION

A. Install per the manufacturer's recommendations.

B. Install temporary roll filter media on all return air ducts prior to start-up. Replace as necessary during construction.

C. Inspect unit for any damage and notify the vendor of same. Repair or replace and damaged components.

D. Cover all units with tarpaulins prior to operation to protect from weather and jobsite damage.

E. Check and maintain required clearances required by the local and National Electric Codes.

F. Formed welded structural steel base rails shall be installed around entire perimeter or unit.

G. Lifting lugs shall be provided where required for proper lifting.

H. Verify the height of housekeeping pad for proper trapping of the condensate drain.

I. Verify power requirements and voltage.

J. Pipe the coils per the detail diagrams in the contract documents.

K. Properly trap the condensate connection for the chilled water coil.

L. Connect electrical power wiring to the motor and the electric heater. Connect electrical power wiring to the electric heater. Two separate power supplies are required.

M. Connect all control wiring and control components.

N. Install filters prior to operation of the system.

O. Flush all chilled and hot water lines of debris and cutting oils. Properly clean the piping with surfactant prior to use.

P. Release the shipping bolts from the fan isolation base and assure the fan is free floating.

Q. Commission the unit and assure that all control algorithms operate properly.

R. Coordinate with Test and Balance Contractor.

END OF SECTION

SECTION 23 73 26

DEDICATED OUTDOOR AIR, AIR HANDLING UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Design, controls, and installation of 100% outdoor air, air handling units.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

C. Section 23 09 23 - Energy Management Control System

D. Section 23 21 13 - Hydronic Piping, Valves and Appurtenances

E. Section 23 23 00 - Refrigerant Piping

F. Section 23 31 13 - Metal Ductwork

1.4 REFERENCES

A. ARI Standard 410 and 430 66

B. AMCA Standard 210, 310, 410, and 500.

C. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

D. UL 181 - Factory-Made Air Ducts & Air Connectors

E. ASTM E84 - Fire & Smoke Rating

F. AMCA 300 - Reverberant Method of Sand Testing

G. NEMA

H. ASHRAE 15 - Safety Standard for Mechanical Refrigeration

1.5 QUALITY ASSURANCE

A. Unit will conform to AMCA 210 for fan performance ratings.

B. Unit will conform to E.T.L. standards. Unit will be ETL listed.

C. Unit sound ratings will be reported in accordance with AHRI 260 for inlet and discharge sound power levels.

D. Unit casing radiated sound ratings will be reported in accordance with ISO 9614 parts 1 and 2, and ANSI S12.12.

E. Unit will conform to AHRI 410 for capacities, pressure drops, and selection procedures of air coils.

F. Unit will conform to ANSI/ AHRI 430 for all fabrication procedures of air handling units.

G. Damper performance will comply with AMCA 500

H. Air handling unit will be ISO 9001 certified.

I. Air handling unit will be manufactured in an ISO 9002 certified facility.

1.6 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 1.

B. Submit unit performance including: capacity, nominal and operating performance, fan curves with fan operating point clearly marked.

C. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

D. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations. Indicate unit shipping, installation and operating weights including dimensions.

E. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.

F. Submit sound power levels by octave band for air handling units at scheduled design conditions. Provide sound power levels for "discharge", "inlet plus cabinet" and “casing radiated” sound paths in accordance with AMCA 300 and AMCA 301. If unit sound power levels exceed values of the scheduled units on drawings, whether the sound power levels are scheduled or not, the contractor shall submit detailed plan outlining steps to meet design noise levels. Comply with ARI-260P and ASHRAE 68.

G. The contractor shall provide a 1/4" scale drawing of the mechanical equipment rooms where all air handling units will be located. The drawing shall show all piping, equipment and required maintenance clearances for the equipment. This drawing shall be furnished prior to commencement of work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of the contract documents. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Each section shall have lifting lugs or shipping skid to allow for field rigging and final placement of section.

B. Deliver units to site with fan motors, sheaves, and belts completely assembled and mounted in units. Mount motors as specified in these contract documents.

C. Store and protect products under provisions of the contract documents.

D. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. The contractor shall be responsible for the repair of the units if any damage occurs due to improper storage and handling. The contractor shall protect the units with tarpaulins, not plastic covering.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.10 EXTRA FILTERS

A. Provide two (2) sets of unit filters. One set, minimum, shall be utilized during the construction phase of the project. During the construction phase of the project the contractor shall maintain clean filters in the unit. The construction filters shall be replaced at time of owner occupancy with clean unused filters.

1.11 STRUCTURAL REQUIREMENTS

A. Provide factory assembled units, in sections sized to meet existing site restrictions. Refer to equipment schedule on drawings for dimensional data.

B. Furnish units with sealing and fastening hardware supplied by the manufacturer. Include written instructions needed to complete field assembly of the components.

C. Provide units designed and constructed so that coils, panels, fan housing and fans can be removed without affecting the structural integrity of the unit. All units shall come complete with a welded structural steel base around the entire perimeter. Provide de-mounts as required to meet site restrictions. All units shall be suitable for Class II design conditions.

1.12 WARRANTY

A. Unit manufacturer shall warrant unit and factory packaged controls for eighteen (18) months from date of shipments or twelve (12) months from manufacturer supervised on-site start-up.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Temtrol

B. Aaon

C. Trane

D. York

E. Daikin

F. Carrier

G. Manufacturer must clearly define any exceptions made to Plans and Specifications. Mechanical Contractor is responsible for expenses that occur due to exceptions made. Substitute equipment may be considered for prior approval, but must include at a minimum the following:
   1. R-410a refrigerant
   2. Hinged access doors with lockable handles
   3. Variable capacity compressor with 10-100% capacity
   4. Modulating hot gas reheat
   5. Heat pump operation
   6. Terminal strip for connection and control by Energy Management Control System

2.2 AIR HANDLING UNIT GENERAL DESCRIPTION

A. Indoor air handling unit shall include filters, supply fans, modulating hot gas reheat coil, DX evaporator coil, VFD, and factory provided controls.

B. Unit shall have a draw-through supply fan configuration and discharge air horizontally or vertically based on plans.

C. Unit shall be factory assembled and tested including leak testing of the coils and run testing of the supply fans and factory wired electrical system.

D. Unit shall have decals and tags to indicate lifting and rigging, service areas, and caution areas for safety and to assist service personnel.

E. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.

F. Installation, Operation and Maintenance manual shall be supplied within the unit.

G. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.

H. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

2.3 CONDENSING UNIT GENERAL DESCRIPTION

A. Condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, and unit controls.

B. Condenser shall include air-cooled condenser coils, condenser fans, discharge and liquid connection valves, and unit controls.

C. Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.

D. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.

E. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.

F. Installation, Operation and Maintenance manual shall be supplied within the unit.

G. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.

H. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

2.4 AIR HANDLING UNIT CONSTRUCTION

A. Unit physical dimensions are shown accurately on drawings. Any deviation from dimensions shown is the responsibility of the contractor to verify all maintenance clearance requirements are met.

B. All cabinet walls and access doors shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.

C. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.

D. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel and prevents exterior condensation on the panel.

E. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Refrigerant piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

F. Access to filters, cooling coil, reheat coil, heaters, supply fans and electrical and controls components shall be through hinged access doors. Stainless steel hinges shall be included on the doors.

G. Access doors shall be flush mounted to cabinetry, with stainless steel removable hinges and quarter-turn, zinc cast handles.

H. Units with cooling coils shall include a 304 stainless steel sloped drain pan. Drain pan connection shall be on the same side as the access door.

I. Cooling coils shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.

J. Horizontal units shall include top-mounted threaded steel retainers to allow field installation of vertical 3/8" - 16 NC hanger rods for hanging the unit from above.

K. Unit shall be provided with standard power block for connecting power to the unit.

L. Unit shall include a factory installed 24V control circuit transformer.

2.5 CONDENSING UNIT CONSTRUCTION

A. Unit shall be completely factory assembled, piped, wired and shipped in one section.

B. Unit shall be specifically designed for outdoor application.

C. Condenser fans shall be vertical (horizontal) discharge, axial flow, direct drive fans.

D. Fan motor shall be weather protected, single phase, direct drive, and open drip proof with inherent overload protection.

E. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum (copper) fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.

F. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.

G. Condenser coils shall be mechanically protected from physical damage by painted galvanized steel louvers (wire grille) covering the full area of the coil.

H. Access to condenser coils, condenser fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles.

I. Unit shall include a forkliftable base.

J. Unit shall be provided with standard power block for connecting power to the unit.

K. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.

2.6 AIR HANDLING UNIT FAN SECTION

A. Unit shall include direct drive or belt drive, unhoused, backward curved or plenum supply fans.

B. Blower and motor assembly shall be dynamically balanced and mounted on rubber isolators.

C. Motor shall be a high efficiency electrically commutated motor.

D. Variable frequency drive shall be factory wired and mounted in the control compartment. Fan motor shall be premium efficiency.

2.7 AIR HANDLING UNIT COOLING COILS

A. Water Coils:
   1. Clearly label supply and return headers on outside of units such that direction of coil water-flow is counter to direction of unit airflow.
   2. Coils shall be proof tested to 300 psig and leak tested under water to 200 psig air pressure.
   3. Construct headers of round copper pipe or cast iron.
   4. Construct tubes of 1/2 inch O.D. minimum 0.016 inch thick copper and construct fins of aluminum.
   5. If two or more coils are stacked in unit, install intermediate drain channels between coils to drain condensate to main drain pans without flooding lower coils or passing condensate through airstream.

B. DX Coils:
   1. Coil shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
   2. Clearly label suction and discharge headers on outside of unit.

3. Coils shall be proof tested to 450 psig and leak tested under water to 300 psig air pressure.
4. Suction headers shall be constructed of copper tubing with connections penetrating unit casing to permit sweat connections to refrigerant lines.
5. Construct tubes of 1/2 inch O.D. minimum 0.016 inch thick copper and construct fins of aluminum.
6. If two or more coils are stacked in unit, install intermediate drain channels between coils to drain condensate to main drain pans without flooding lower coils or passing condensate through airstream.
7. Coil shall be furnished with a factory installed thermostatic expansion valve. The sensing bulbs shall be field installed on the suction line immediately outside the cabinet.

2.8 SYSTEM OPTIONS

A. Modulating hot gas reheat shall be provided on the lead refrigeration circuit. Refrigeration circuit shall be provided with (interlaced) hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. Modulating reheat valves shall be factory installed. Reheat line connections shall be labeled, extend beyond the unit casing and be located near the suction and liquid line connections for ease of field connection. Connections shall be factory sealed with a grommet on the exterior of the unit casing to minimize air leakage.

B. Lead refrigerant circuit shall be provided with external hot gas bypass to protect against evaporator frosting at low suction pressure and to prevent excessive compressor cycling. Hot gas bypass line connections shall be labeled, extend beyond the unit casing and be located near the suction and liquid line connections for ease of field connection. Connections shall be factory sealed with a grommet on the exterior of the unit casing to minimize air leakage.

C. Unit shall be configured as heat pump. Refrigeration circuit shall be equipped with thermal expansion and check valve on the indoor coil.

D. Compressors shall be variable capacity scroll type compressors with thermal overload protection. Compressors shall be capable of modulation from 10-100% of the system's capacity. Compressors shall, carry a 10-year non-prorated warranty.

E. Each compressor shall include a crankcase heater.

F. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.

G. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.

H. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided. Finished field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line (insulated hot gas bypass line) (insulated hot gas line) and insulated suction line.

I. Unit shall include a factory holding charge of R-410A refrigerant and oil.

J. Unit shall include infinite stages of capacity control.

K. Each compressor shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.

L. The unit shall be capable of stable cooling operation to a minimum of 55°F outdoor temperature.

M. Refrigeration circuit shall be equipped with a liquid line sight glass.

N. Unit shall include 2” thick, pleated panel pre filters with a MERV 7 rating, upstream of the coil.

PART 3 EXECUTION

3.1 INSTALLATION AND OPERATION

A. Installation, Operation and Maintenance manual shall be supplied with the unit.

B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions. Contractor shall provide final refrigerant lineset installation diagram for approval by equipment manufacturer.

C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

D. Unit shall be provided with a terminal strip for connection and control by the Energy Management Control System.

E. Manufacturer shall provide start-up services for all equipment. This work shall not be done by the installing mechanical contractor (no exceptions).

END OF SECTION

SECTION 23 74 13

ROOFTOP CENTRAL STATION AIR HANDLING UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Rooftop packaged air handling units.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

C. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

D. Section 23 09 23 - Energy Management Control System

E. Section 23 31 13 - Metal Ductwork

1.4 REFERENCES

A. ARI 430 - Standard for Central Station Air Handling Units.

B. ARI 410 - Standard for Forced Circulation Air-Cooling and Air-Heating Coils.

C. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

D. UL 1995 - Heating and Cooling Equipment

E. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

F. SMACNA - HVAC Duct Construction Standards.

G. ANSI/UL 900 - Test Performance of Air Filter Units.

H. AMCA 300 - Reverberant Method for Sound Testing of Fans.

I. AMCA 301 - Method for Publishing Sound Ratings for Air Moving Devices.

J. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.

K. Ul1995 - Heating and Cooling Equipment

1.5 QUALITY ASSURANCE

A. Air Handling Units: Product of manufacturer regularly engaged in production of components who issues complete catalog data on product offering.

B. Constant Volume and Variable Air Volume Air Handling Units: Certify air volume, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI 430. If air handling units are not certified in accordance with ARI 430, contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fans. Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

C. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-91.

1.6 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

B. Submit unit performance including: capacity, nominal and operating performance.

C. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

D. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.

E. Provide fan curves with specified operating point clearly plotted.

F. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions the contract documents. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Each section shall have lifting lugs to allow for field rigging and final placement of section.

B. Deliver units to site with fan motors, sheaves, and belts completely assembled and mounted in units. Mount motors as specified in these contract documents.

C. Outdoor units shall have coverings protected and weatherproof.

D. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. The contractor shall be responsible for the repair of the units if any damage occurs due to improper storage and handling. The contractor shall protect the units with tarpaulins, not plastic covering.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.9 EXTRA FILTERS

A. Provide two (2) sets of unit filters. One set, minimum, shall be utilized during the construction phase of the project. During the construction phase of the project the contractor shall maintain clean filters in the unit. The construction filters shall be replaced at time of owner occupancy with clean unused filters.

1.10 WARRANTY

A. Unit manufacturer shall warrant unit and factory packaged controls for eighteen (18) months from date of shipments or twelve (12) months from manufacturer supervised on-site start-up.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Temtrol

B. Aaon

C. Trane

D. York

E. Daikin

F. Carrier

2.2 GENERAL

A. Manufacturer must clearly define any exceptions made to Plans and Specifications. Mechanical Contractor is responsible for expenses that occur due to exceptions made.

B. Unit will be complete with fan(s), motors, coils, dampers, access doors and other components/ options as described and scheduled on drawings.

C. Unit must be specifically designed for outdoor installation.

D. Fabricate draw-thru type air handling units with fan sections.

E. Factory fabricate air handling units of sizes, capacities, and configurations as scheduled on drawings.

F. Unless otherwise specified, provide at minimum 18” access door between all coils for cleaning and inspection.

2.3 UNIT BASE

A. Provide formed or welded structural steel base rails shall be installed around entire perimeter or unit to support all sections.

B. Base shall be welded supporting the entire length and width of the unit. Units shipped in one piece shall have at a minimum six points of lift. These lift points shall be designed to accept standard rigging devices.

C. The unit base design shall allow unit to rest on top of roof curb when field installed. Entire length and width under base shall be sealed in the field with curb gasketing for weather tight seal.

2.4 CASING

A. All panels shall be double wall construction. Interior and exterior panels shall be constructed of galvanized steel. Panel insulation system shall provide a minimum R value of 13. Insulation shall conform to NFPA 90 requirements.

B. Casing shall have full size removable access doors. Access doors shall have double wall construction. Provide automotive style neoprene gasketing around full perimeter of access doors to prevent air leakage. Provide "ventlock" style non-corrosive alloy latches operable from the inside or outside of unit. If access doors open against unit operating pressure, provide safety latches that allow access doors to partially open after first handle movement and fully open after second handle movement.

C. Unit will conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1% of design airflow at 8” of total static pressure.

D. Wall panels and access doors will deflect no more than L/240 when subjected to 8” of total static pressure. Floor panels will be double wall construction, designed to provide at most L/240 deflection when subjected to a 300lb. point load at mid span.

E. Perforated interior liner with fiberglass insulation shall be applied to all discharge plenum and fan sections.

F. External surface of unit casing shall be prepared and factory coated with a minimum 1.5 mil enamel finish or equal. Unit casing exterior with factory coating shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 672 consecutive hours. Unit casing will be provided with manufacturer's standard color.

G. Unit roof shall be sloped a minimum 0.25 inch per foot either from one side of unit to other or from center to sides of the unit. Roof assembly shall overhang all walls of units by 2 inch minimum.

H. For units with outside air requirements, manufacturer shall provide inlet hood with high performance sine wave moisture eliminator to prevent water carryover into unit casing from outside air. Hoods shall be sized for 100% outside air capacity.

I. Galvanized steel roof mounting curb with wood nailing strip, and neoprene gasket shall be supplied by the unit manufacturer. If unit requires external piping cabinet, a separate curb shall be supplied for support of the external cabinet. The minimum height of the roof mounting curb shall be EIGHTEEN (18) inches, unless otherwise specified.

J. All view ports will be double-pane UV resistant tempered glass

2.5 DRAIN PAN CONSTRUCTION

A. Provide sealed double wall insulated drain pans constructed of galvanized steel exterior panels and stainless steel interior liner.
   1. Coil supports and bulkheads shall be 304 Stainless Steel
   2. Encase insulation between exterior and interior walls.
   3. Drain pans shall be double sloped at least 1/8” per foot and have no horizontal surfaces.
   4. Drain pans shall drain to one point.

5. Drain connections shall be welded to drain pans.
6. Drain pans shall have at least 1" clearance between pan and coil supports.

2.6 FANS SECTIONS

A. Units shall be provided with the fan configurations (Quantity) shown in the schedule. Units provided with fewer fans will not be acceptable.

B. The Fan Wall System, as manufactured by CES Inc., shall consist of multiple, direct driven, arrangement plenum fans constructed per AMCA requirements for the duty specified. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The Fan Wall Array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include an 11 gauge, A60 Galvanized steel intake wall, 14 gauge spun steel inlet funnel, and an 11 gauge G90 Galvanized steel motor support plate and structure. The fan intake wall, inlet funnel, and motor support structure shall be powder coated for superior corrosion resistance. All motors shall be high efficiency pedestal mounted type, T-frame motors selected at the specified operating voltage and RPM, as specified or as scheduled elsewhere. All motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.

C. The FWT array shall be provided with acoustical silencers that reduce the bare fan discharge sound power levels by a minimum of 15 db re 10^-12 watts throughout the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same unit without the silencers. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the Air Handling Unit when compared to the same FWT unit without the silencer array.

D. The fan array shall consist of multiple fan and motor "cubes", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. Each fan cube shall be individually wired to a motor overload control panel for a connection to a single VFD, as specified elsewhere, for the total connected HP for all fan motors contained in the FWT array. Panel shall have individual motor overloads for each motor. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards.

E. The Fan Wall array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the Fan Wall array intake plenum wall, and at a distance of 48" from the discharge side of the Fan Wall intake plenum wall.

F. Each fan/motor assembly shall be removable through a 30" wide, free area, access door located on the discharge side of the fan wall array.

G. The unit must be provided with a close-off plate to cover a fan cube upon failure. Back-draft dampers are not acceptable. Provide fans with zero net effect vertical backdraft dampers. These non-controlled dampers shall provide for isolation in event a fan fails or is turned off. Ruskin type or weighted backdraft dampers are not acceptable.

H. The manufacturer shall have at least two years of experience in the fabrication and installation of fan wall arrays.

I. Motors greater than 10 HP must have 1 motor removal rail per row of fans.

J. TEFC, TEAO or ECM motors only. ODP motors not allowed.

K. Motors shall be 1800 rpm or 3500 rpm (900 rpm and 1200 rpm motors are not acceptable). Motors using VFD's shall comply with the requirements of NEMA MG 1 part 31 section 31.40.4.2 for peak voltage withstand capability.

Motor HP	Full Load Nominal Efficiency	3/4 Load Efficiency	2/4 Load Efficiency
3	88.5	88.5	87.5
5	89.5	89.5	89.2
7-1/2	90.2	91.0	90.8

2.7 COILS SECTION

A. Coils shall be manufactured by the same company as the supplier of the air handling unit. Install coils such that headers and return bends are enclosed by unit casings.

B. All coils shall have capacity and pressure drop performance certified in accordance with AHRI Standard 410.

C. Maximum face velocity across coils shall be 490 fpm.

D. Coils shall be manufactured by the same company as the supplier of the air handling unit. Install coils such that headers and return bends are fully enclosed by unit casings.

E. Coils shall have aluminum fins and seamless copper tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of tubes. Do not use soldering or tinning in bonding process.

F. Construct coil casings of 304 stainless steel with formed end supports and top and bottom channels.

G. Coils will be removable from the side of the unit via removable air handling unit panel. No more than one panel must be removed in order to remove coil.

H. Water Cooling and Heating Coils:
1. Clearly label supply and return headers on outside of units such that direction of coil water flow is counter to direction of unit airflow.
2. Coils shall be proof tested to 300 psig and leak tested to 200 psig air pressure under water.
3. Construct headers of round copper pipe or cast iron.
4. Construct tubes of 1/2 inch O.D. minimum .016 inch thick copper and construct fins of aluminum.

I. DX Coils:
1. Clearly label suction and discharge headers on outside of unit.
2. Coils shall be proof tested to 450 psig and leak tested under water to 300 psig air pressure.
3. After testing, the inside of the coils shall be dried, all connections shall be sealed, and the coil shall be shipped with a charge of dry nitrogen.
4. Suction headers shall be constructed of copper tubing with connections penetrating unit casing to permit sweat connections to refrigerant lines.
5. Construct tubes of 1/2 inch O.D. minimum 0.016 inch thick copper and construct fins of aluminum.

6. If two or more coils are stacked in unit, install intermediate drain channels between coils to drain condensate to main drain pans without flooding lower coils or passing condensate through airstream.

2.8 ELECTRIC HEAT SECTION

A. Provide electric heating coils as scheduled. For pre-heat applications, coil shall be constructed with open-coil type A resistance elements, 80% nickel, 20% chromium. Type C alloys containing iron or other alloys are not acceptable.

B. Heaters shall be furnished with a disc type, automatic reset thermal cutout for primary over temperature protection. Heaters shall also be furnished with disc type, load carrying manual reset thermal cutouts, factory wired in series with heater stages for secondary protection. Heater limiters or other fusible over temperature devices are not acceptable.

C. Heaters shall be rated for the voltage, phase and number of heating stages indicated on the schedule. All three-phase heaters shall have equal, balanced, three-phase stages.

D. Electric heater shall be factory wired to an electronic step controller relay bank. This type of control may be connected to a 0-10VDC or 4-20mA signal from a standalone thermostat or building automation system, which is converted to stages of heat.

E. Terminal blocks shall be provided for all field wiring and shall be sized for installation of 75 degree C copper wire rated in accordance with NEC table 310-16, not more than three conductors in a conduit.

2.9 GAS HEAT SECTION

A. The gas heat section construction shall match the rest of the air handling unit and be an integral part of the air handling unit.

B. Indirect fired gas heaters shall be completely factory assembled, piped, and operationally fire tested at the factory prior to shipment.

C. Heat exchanger primary drum and secondary tubes shall be constructed of 14 gauge, 409 stainless steel. Industrial burner shall be UL listed, force draft, and fully modulating.

D. The entire gas heating section shall bear a UL label for Commercial-Industrial Gas Heating Equipment (ANSI/ UL Standard 795) and Industrial Gas-Fired Package Furnaces (CGA Standard 3.2-1976).

2.10 EXTERNAL PIPING ENCLOSURE

A. Piping enclosure shall be supplied by the manufacturer factory assembled and shall be of the same construction as the main unit casing. Piping cabinet shall be external to the unit and be shipped separate for field installation in order to facilitate piping of the unit coils. Piping cabinet to cover all coils and access sections located between the coils. All piping enclosures shall have access doors.

2.11 FILTERS

A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter sections shall have filter guides and full height, double-wall, hinged doors for filter removal. Construct doors in accordance with all other access doors described herein. Filter sections shall flange to other unit components. Provide filter blockoffs as required to prevent air bypass around filters.

B. Provide two (2) sets of unit filters. One set, minimum, shall be utilized during the construction phase of the project. During the construction phase of the project the contractor shall maintain clean filters in the unit. The construction filters shall be replaced at time of owner occupancy with clean unused filters.

2.12 DAMPERS AND MIXING BOXES

A. Provide dampers to modulate the volume of return air, outside air and exhaust air. Damper blades shall be galvanized steel, housed in a galvanized steel frame and mechanically fastened to an axle rod rotating on bearings. Blade seals are required to assure tight closure. All dampers shall be rated for a maximum leakage rate of less than 1 percent of nominal CFM at one-inch w.g. All dampers shall be rated for the full airflow volume of the unit. Mixing boxes shall be included to properly mix the various air streams.

2.13 ACCESS SECTIONS

A. Access for inspection and cleaning of the unit drain pan, coils and fan section shall be provided. The minimum depth of access section shall be eighteen (18) inches between the coils. Procedures for proper access, inspection and cleaning of the unit shall be included in the maintenance manual. Access sections shall have double wall, hinged doors on one side of sections. The access section shall be placed between cooling and heating coils.

2.14 DISCHARGE PLENUM SECTIONS

A. All units unless otherwise noted, shall be provided with discharge plenum sections located downstream of the fan section. The discharge plenum shall be constructed the same as the unit casing. The unit interior shall be constructed with a perforated liner over the insulation. The fan outlet shall be on the bottom of the section. The contractor shall insert bell mouth outlets into the openings for discharge into the duct system. Most units will have multiple openings required.

B. An access door shall be provided on the plenum section constructed the same as the other access doors. The access door shall be capable of withstanding the operating pressure of the fan without deflection. The door shall be labeled “High Pressure Section - FAN MUST BE OFF BEFORE OPENING”. This label shall be permanently affixed to the unit and be written in both English and Spanish.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install per the manufacturer’s recommendations.

B. Install temporary roll filter media on all return air ducts prior to start-up. Replace as necessary during construction.

C. Inspect unit for any damage and notify the vendor of same. Repair or replace and damaged components.

D. Cover all units with tarpaulins prior to operation to protect from weather and jobsite damage.

E. Check and maintain required clearances required by the local and National Electric Codes.

F. Verify the height of roof curb for proper trapping of the condensate drain.

G. Verify power requirements and voltage.

H. Lifting lugs shall be provided where required for proper lifting.

I. Pipe the coils per the detail diagrams in the contract documents.

J. Connect electrical power wiring to the motor and the electric heater (as required). Connect electrical power wiring to the electric heater. Two separate power supplies are required for each fan motor.

K. Connect all control wiring and control components.

L. Install filters prior to operation of the system.

M. Flush all chilled water lines of debris and cutting oils. Properly clean the piping with surfactant prior to use.

N. Release the shipping bolts from the fan isolation base and assure the fan is free floating.

O. Commission the unit and assure that all control algorithms operate properly.

P. Coordinate with Test and Balance Contractor.

END OF SECTION

SECTION 23 74 33

PACKAGED DEDICATED OUTDOOR AIR HANDLING UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Rooftop packaged 100% outdoor air and economizer units.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

C. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

D. Section 23 09 23 - Energy Management Control System

E. Section 23 31 13 - Metal Ductwork

1.4 REFERENCES

A. ARI 430 - Standard for Central Station Air Handling Units.

B. ARI 410 - Standard for Forced Circulation Air-Cooling and Air-Heating Coils.

C. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

D. UL 1995 - Heating and Cooling Equipment

E. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

F. SMACNA - HVAC Duct Construction Standards.

G. ANSI/UL 900 - Test Performance of Air Filter Units.

H. AMCA 300 - Reverberant Method for Sound Testing of Fans.

I. AMCA 301 - Method for Publishing Sound Ratings for Air Moving Devices.

J. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.

K. Ul1995 - Heating and Cooling Equipment

1.5 QUALITY ASSURANCE

A. Air Handling Units: Product of manufacturer regularly engaged in production of components who issues complete catalog data on product offering.

B. Constant Volume and Variable Air Volume Air Handling Units: Certify air volume, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI 430. If air handling units are not certified in accordance with ARI 430, contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fans. Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

C. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-91.

1.6 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 01.

B. Submit unit performance including: capacity, nominal and operating performance.

C. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

D. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.

E. Provide fan curves with specified operating point clearly plotted.

F. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions the contract documents. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Each section shall have lifting lugs to allow for field rigging and final placement of section.

B. Deliver units to site with fan motors, sheaves, and belts completely assembled and mounted in units. Mount motors as specified in these contract documents.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. The contractor shall be responsible for the repair of the units if any damage occurs due to improper storage and handling. The contractor shall protect the units with tarpaulins, not plastic covering.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.9 EXTRA FILTERS

A. Provide two (2) sets of unit filters. One set, minimum, shall be utilized during the construction phase of the project. During the construction phase of the project the contractor shall maintain clean filters in the unit. The construction filters shall be replaced at time of owner occupancy with clean unused filters.

1.10 WARRANTY

A. Unit manufacturer shall warrant unit and factory packaged controls for eighteen (18) months from date of shipments or twelve (12) months from manufacturer supervised on-site start-up.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Trane

B. York

C. Aaon

D. Daikin

2.2 GENERAL

A. Manufacturer must clearly define any exceptions made to Plans and Specifications. Mechanical Contractor is responsible for expenses that occur due to exceptions made.

B. Packaged outdoor air ventilation unit shall be complete with Variable Speed Driven (VSD) fan(s), motors, coils, dampers, access doors and other components/ options as described and scheduled on drawings.

C. Unit must be specifically designed for outdoor installation.

D. Fabricate draw-thru type air handling units with fan sections.

E. Factory fabricate air handling units of sizes, capacities, and configurations as scheduled on drawings.

F. The unit shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g. whichever is less, with no more than 0.005 inch deflection per inch of panel span.

2.3 UNIT BASE

A. Base shall be welded supporting the entire length and width of the unit. Units shipped in one piece shall have at a minimum six points of lift. These lift points shall be designed to accept standard rigging devices.

B. The unit base design shall allow unit to rest on top of roof curb when field installed. Entire length and width under base shall be sealed in the field with curb gasketing for weather tight seal.

2.4 CASING

A. All panels shall be double wall construction. Interior and exterior panels shall be constructed of galvanized steel. Panel insulation system shall provide a minimum R value of 12. Insulation shall conform to NFPA 90 requirements.

B. Access doors shall be constructed with a double-wall of solid G90 galvanized steel interior panel. Gasketing around the full perimeter of the access door shall be used to prevent air and water leakage. Door handle shall not penetrate door casing with single-handle latch.

C. Perforated interior liner with fiberglass insulation shall be applied to all discharge plenum and fan sections.

D. External surface of unit casing shall be prepared and factory coated with a minimum 1.5 mil enamel finish or equal. Unit casing exterior with factory coating shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 672 consecutive hours. Unit casing will be provided with manufacturer's standard color.

E. Unit roof shall be sloped a minimum 0.25 inch per foot either from one side of unit to other or from center to sides of the unit. Roof assembly shall overhang all walls of units by 2 inch minimum.

F. For units with outside air requirements, manufacturer shall provide inlet hood with high performance sine wave moisture eliminator to prevent water carryover into unit casing from outside air. Hoods shall be sized for 100% outside air capacity.

G. Galvanized steel roof mounting curb with wood nailing strip, and neoprene gasket shall be supplied by the unit manufacturer. If unit requires external piping cabinet, a separate curb shall be supplied for support of the external cabinet. The minimum height of the roof mounting curb shall be EIGHTEEN (18) inches, unless otherwise specified.

2.5 DRAIN PAN CONSTRUCTION

A. Provide sealed double wall drain pans constructed of G90-U galvanized steel exterior panels and G90-U galvanized steel interior liner. Encase insulation between exterior and interior walls. Drain pans shall be sloped in 2 planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Units with cooling coils shall have drain pans under complete cooling coil section. Units with heating coils shall have a drain pan under complete heating coil segment to ensure proper drainage during cleaning. Units with cooling and heating coils shall be provided with an access section between coils that shall also have a sloped drain pan as described herein. All drain pan connections will be to the side of the unit to enable proper trapping. Units without 2-way sloped drain pans shall coat drain pans with anti-microbial treatment.

2.6 FAN SECTIONS

A. For units scheduled with housed fans, provide supply fan section and exhaust fans (if shown or scheduled on the plans) with forward curved (FC) or airfoil (AF) double width, double inlet centrifugal fan designed and suitable for class of service indicated in the unit schedule. Fan shaft to be properly sized and protectively coated with lubricating oil. Fan shafts shall be solid and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. Fans shall be statically and dynamically tested as an assembly at the required RPM to meet design specifications. Key fan wheels to fan shaft to prevent slipping.

B. Provide self-aligning, grease lubricated pillow-block ball bearings selected for L-50 200,000 hour average life per ANSI/AFBMA 9. Extend both grease lubrication fittings to drive side of unit with plastic tubes and zerk fittings rigidly attached to drive side bearing support.

C. On units scheduled with plug fans, provide supply fan sections with AF single width, single inlet centrifugal plug fans designed and suitable for class of service indicated on unit schedule. Fan shaft to be properly sized and protectively coated width lubricating oil. Fan shafts shall be solid and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. Fans shall be statically and dynamically tested as an assembly at the required RPM to meet design specifications. Key fan wheels to fan shaft to prevent slipping.

D. Equip centrifugal plug fans with self-aligning, grease lubricated pillow-block ball bearings selected for L-50 400,000 hour average life per ANSI/AFBMA 9. Extend both grease lubrication fittings to drive side of unit with plastic tubes and zerk fittings rigidly attached to drive side bearing support.

E. Mount fans on isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with one (1) inch spring isolators. Install flexible canvas ducts between fan and casings to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A. If no isolators or flexible canvas duct is provided, then the entire unit shall be externally isolated from the supply duct work and piping by contractor in order to avoid transmission of noise and vibration through the ductwork.

F. Fan sections shall have full height, double wall, hinged doors on drive side for inspection and maintenance of internal components. Construct doors in accordance with these contract documents.

G. Fan sections with plug fans shall have galvanized expanded metal access door guards to prevent unauthorized entry into fan sections when access doors are opened. Design access door guards for removal from outside of unit. On plug fan sections with vertical down discharge, a safety grate shall cover the entire discharge opening to prevent service personnel from falling into supply air ductwork.

H. Weigh fan and motor assembly at AHU manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions. Balance at design RPM as scheduled on drawings.

I. For fan sections controlled by variable frequency drives, balance the fan assembly at speeds between 25% and 100% of design RPM.

2.7 MOTORS AND DRIVES

A. Factory install all motors on slide base to permit adjustment of belt tension.

B. Fan Motors shall be heavy duty, HIGH EFFICIENCY (minimum 92% at full load) open drip-proof, operable at the scheduled electrical requirements.

C. V-Belt Drive shall be fixed pitch rated at 1.2 times the motor nameplate for all fans controlled with a variable frequency drive. All fans that are constant volume, including exhaust fans, shall be provided with variable pitch drives rated at 1.2 times the motor nameplate HP.

2.8 COILS SECTION

A. Coils shall be manufactured by the same company as the supplier of the air handling unit. Install coils such that headers and return bends are enclosed by unit casings.

B. All coils shall have capacity and pressure drop performance certified in accordance with AHRI Standard 410.

C. Maximum face velocity across coils shall be 490 fpm.

D. Coils shall be manufactured by the same company as the supplier of the air handling unit. Install coils such that headers and return bends are fully enclosed by unit casings.

E. Coils shall have aluminum fins and seamless copper tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of tubes. Do not use soldering or tinning in bonding process.

F. Construct coil casings of stainless steel with formed end supports and top and bottom channels.

G. Coils will be removable from the side of the unit via removable air handling unit panel. No more than one panel must be removed in order to remove coil.

H. Water Cooling and Heating Coils:
   1. Clearly label supply and return headers on outside of units such that direction of coil water flow is counter to direction of unit airflow.
   2. Coils shall be proof tested to 300 psig and leak tested to 200 psig air pressure under water.
   3. Construct headers of round copper pipe or cast iron.
   4. Construct tubes of 1/2 inch O.D. minimum .016 inch thick copper and construct fins of aluminum.
   5. Unit shall be provided with a heating coil in the preheat position and a heating coil in the reheat position.

I. DX Coils:
   1. Clearly label suction and discharge headers on outside of unit.
   2. Coils shall be proof tested to 450 psig and leak tested under water to 300 psig air pressure.
   3. After testing, the inside of the coils shall be dried, all connections shall be sealed, and the coil shall be shipped with a charge of dry nitrogen.
   4. Suction headers shall be constructed of copper tubing with connections penetrating unit casing to permit sweat connections to refrigerant lines.
   5. Construct tubes of 1/2 inch O.D. minimum 0.016 inch thick copper and construct fins of aluminum.
   6. If two or more coils are stacked in unit, install intermediate drain channels between coils to drain condensate to main drain pans without flooding lower coils or passing condensate through airstream.
   7. Unit shall be provided with modulating hot gas reheat.

2.9 ELECTRIC HEAT SECTION

A. Provide electric heating coils as scheduled. For pre-heat applications, coil shall be constructed with open-coil type A resistance elements, 80% nickel, 20% chromium. Type C alloys containing iron or other alloys are not acceptable.

B. Heaters shall be furnished with a disc type, automatic reset thermal cutout for primary over temperature protection. Heaters shall also be furnished with disc type, load carrying manual reset thermal cutouts, factory wired in series with heater stages for secondary protection. Heater limiters or other fusible over temperature devices are not acceptable.

C. Heaters shall be rated for the voltage, phase and number of heating stages indicated on the schedule. All three-phase heaters shall have equal, balanced, three-phase stages.

D. Electric heater shall be factory wired to an electronic step controller relay bank. This type of control may be connected to a 0-10VDC or 4-20mA signal from a standalone thermostat or building automation system, which is converted to stages of heat.

E. Terminal blocks shall be provided for all field wiring and shall be sized for installation of 75 degree C copper wire rated in accordance with NEC table 310-16, not more than three conductors in a conduit.

2.10 GAS HEAT SECTION

A. The gas heat section construction shall match the rest of the air handling unit and be an integral part of the air handling unit.

B. Indirect fired gas heaters shall be completely factory assembled, piped, and operationally fire tested at the factory prior to shipment.

C. Heat exchanger primary drum and secondary tubes shall be constructed of 14 gauge, 409 stainless steel. Industrial burner shall be UL listed, force draft, and fully modulating.

D. The entire gas heating section shall bear a UL label for Commercial-Industrial Gas Heating Equipment (ANSI/ UL Standard 795) and Industrial Gas-Fired Package Furnaces (CGA Standard 3.2-1976).

2.11 EXTERNAL PIPING ENCLOSURE

A. Piping enclosure shall be supplied by the manufacturer factory assembled and shall be of the same construction as the main unit casing. Piping cabinet shall be external to the unit and be shipped separate for field installation in order to facilitate piping of the unit coils. Piping cabinet to cover all coils and access sections located between the coils. All piping enclosures shall have access doors.

2.12 FILTERS

A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter sections shall have filter guides and full height, double-wall, hinged doors for filter removal. Construct doors in accordance with all other access doors described herein. Filter sections shall flange to other unit components. Provide filter blockoffs as required to prevent air bypass around filters.

B. Provide two (2) sets of unit filters. One set, minimum, shall be utilized during the construction phase of the project. During the construction phase of the project the contractor shall maintain clean filters in the unit. The construction filters shall be replaced at time of owner occupancy with clean unused filters.

2.13 DAMPERS AND MIXING BOXES

A. Provide dampers to modulate the volume of outside air and relief air, if applicable. Damper blades shall be galvanized steel, housed in a galvanized steel frame and mechanically

fastened to an axle rod rotating on bearings. Blade seals are required to assure tight closure. All dampers shall be rated for a maximum leakage rate of less than 1 percent of nominal CFM at one-inch w.g. All dampers shall be rated for the full airflow volume of the unit. Mixing boxes shall be included to properly mix the various air streams.

2.14 ACCESS SECTIONS

A. Access for inspection and cleaning of the unit drain pan, coils and fan section shall be provided. The minimum depth of access section shall be FIFTEEN (15) inches between the coils. Procedures for proper access, inspection and cleaning of the unit shall be included in the maintenance manual. Access sections shall have double wall, hinged doors on one side of sections. The access section shall be placed between cooling and heating coils.

2.15 DISCHARGE PLENUM SECTIONS

A. All units unless otherwise noted, shall be provided with discharge plenum sections located downstream of the fan section. The discharge plenum shall be constructed the same as the unit casing. The unit interior shall be constructed with a perforated liner over the insulation. The fan outlet shall be on the bottom of the section. The contractor shall insert bell mouth outlets into the openings for discharge into the duct system. Most units will have multiple openings required.

B. An access door shall be provided on the plenum section constructed the same as the other access doors. The access door shall be capable of withstanding the operating pressure of the fan without deflection. The door shall be labeled “High Pressure Section - FAN MUST BE OFF BEFORE OPENING”. This label shall be permanently affixed to the unit and be written in both English and Spanish.

PART 3 EXECUTION

3.1 INSTALLATION AND OPERATION

A. Install per the manufacturer’s recommendations.

B. Start up to be provided by unit manufacturer.

C. Install temporary roll filter media on all return air ducts prior to start-up. Replace as necessary during construction.

D. Inspect unit for any damage and notify the vendor of same. Repair or replace and damaged components.

E. Cover all units with tarpaulins prior to operation to protect from weather and jobsite damage.

F. Check and maintain required clearances required by the local and National Electric Codes.

G. Verify the height of roof curb for proper trapping of the condensate drain.

H. Verify power requirements and voltage.

I. Lifting lugs shall be provided where required for proper lifting.

J. Pipe the coils per the detail diagrams in the contract documents.

K. Connect electrical power wiring to the motor and the electric heater (as required). Connect electrical power wiring to the electric heater. Two separate power supplies are required for each fan motor.

L. Connect all control wiring and control components.

M. Install filters prior to operation of the system.

N. Flush all chilled water lines of debris and cutting oils. Properly clean the piping with surfactant prior to use.

O. Release the shipping bolts from the fan isolation base and assure the fan is free floating.

P. Commission the unit and assure that all control algorithms operate properly.

Q. Coordinate with Test and Balance Contractor.

END OF SECTIONSECTION 23 81 19

PACKAGED HVAC UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 01 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Rooftop mounted or ground mounted packaged HVAC units.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

C. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

D. Section 23 09 23 - Energy Management Control System

E. Section 23 31 13 - Metal Ductwork

1.4 REFERENCES

Underwriters Laboratory	UL Listed
NFPA 90 A & B	Installation of Air Conditioning and Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems.
ANSI/ASHRAE 15	Safety Code for Mechanical Refrigeration.
AHRI 360	Commercial and Industrial Unitary Air Conditioning Equipment testing and rating standard.
AHRI 340	Commercial and Industrial Unitary Heat pump Equipment.
ANSI/ASHRAE 37	Testing Unitary Air Conditioning and Heat Pump Equipment.
ANSI/ASHRAE/IES 90.1A	Energy Conservation in New Building Design Standard.
ANSI/UL 465	Central Cooling Air Conditioners Standard for safety requirements.
AHRI 210/240	Unitary Air Conditioning Equipment and Air-Source Heat Pump Equipment.
AHRI 270	Sound Rating of Outdoor Unitary Equipment.
ANSI/NFPA 70-1990	National Electric Code (NEC).
AGA	American Gas Association

1.5 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 01.
   2. Submit product data indicating typical catalog of information including arrangements.
   3. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication. List all accessories available for units and clearly mark accessories being provided. List all field-installed items.

4. Provide in table form a schedule similar to drawings with data listing all information, capacities, fan data, voltages, accessories, etc.
5. Indicate mechanical and electrical service locations and requirements.
6. Submit manufacturer's installation instructions.

B. Shop Drawings:
1. Submit 1/4" per foot shop drawing(s) showing all piping, ductwork, and equipment shown by drawings and specifications. Submit drawings on all mechanical rooms. The drawings shall be coordinated with structural, and electrical, and fire sprinkler drawings.

C. **Equipment Start-up Report**
1. **Submit an equipment start up report as provided by the equipment manufacturer. Start- up report shall include the following, but not limited to: verification of system air flow, proper operation of all motors and fans, proper tensioning of belts and pulleys, proper operation of on-board microprocessor control system, proper control of economizer damper, proper compressor operation, and proper operation of cooling, heating, and dehumidification modes.**

1.6 QUALITY ASSURANCE

A. UL listed and must display UL label on all units.

B. All units must comply with ASHRAE Standard 90.1 and the applicable International Energy Conservation Code.

C. Unit performance data must be rated in accordance with AHRI Standard 210/240, and must display the AHRI symbol on all standard units.

D. Conform to applicable ANSI/NFPA 70 code for internal wiring of factory wired equipment.

E. AGA, with label.

F. Tested in accordance with DOE.

G. The air-conditioning equipment manufacturer shall be solely responsible for their equipment that does not comply with the performance of their published catalogues and specifications.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, including filter replacement and unit lubrication.

1.8 WARRANTY

A. Complete 1-year parts and labor warranty on all equipment

B. 5-year warranty provided for the compressors.

C. 15-year warranty provided for heat exchangers.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. All units are to comply with ASHRAE Standard 90.1.

B. All units are to be tested in accordance with AHRI 360, AHRI 340, AHRI 210/240 and Bear Label.

2.2 MANUFACTURERS

A. Aaon

B. Lennox

C. Trane

D. Daikin

E. Unit SEER/ EER values shall meet or exceed Energy Efficiency Ratios per schedule.

2.3 PACKAGED HEATING/COOLING UNITS

A. **All units to have standard mechanical thermostat terminal strip for 3rd party control. Units with OEM branded controls and/or integration boards not allowed. Controls to be provided by others.**

B. All units 3 tons to 6 tons are to have two stage compressor and a minimum two speed fan.

C. All units 7.5 tons and above are to have a minimum two compressors with dual refrigeration circuits.

D. Minimum Cooling Efficiencies:
   1. EER ratings by AHRI Standard 210/ 240 and AHRI Standard 340/360:
      a. All units to comply with ASHRAE 90.1.
      b. All units to comply with International Energy Conservation Code 2015.

E. Gas Furnace Design:
   1. Heating capacities:
      a. Equal to or greater than those shown on plans. Bear AGA label.
   2. Ignition:
      a. Electronic pilot ignition
      b. Standing pilot not allowed
   3. Efficiency:
      a. Minimum 80% A.F.U.E. rating.

F. Electric Furnace Design:
   1. Heating Capacities:
      a. As scheduled on plans at rated voltage. UL Listed with label, meets NEC.

G. Three Phase Electrical Power:
   1. Impose an equal electrical load on all phases of heater.
   2. Electrical resistance elements which are not balanced over all three phases are not acceptable.

H. Construction:
   1. Design for roof curb mounting with "downshot" duct connection. Full perimeter curb only.

2. Units which require the installation of a separate plenum (such as side discharge units) are not acceptable.
3. Coils: copper tubes, aluminum fins, factory test 450 psig, metal hail guards for all condenser coils. Aluminum microchannel condenser coils are acceptable.
    a. Features:
        (1) Easy access to filters, 2" filter rack
        (2) Factory installed 1" filters
        (3) Low voltage terminal board
        (4) All blowers shall deliver a minimum of 450 cfm/ton at .5" E.S.P.
        (5) Filter racks to be provided at each unit.
        (6) High efficiency motors.
4. **Return air and economizer compartment with 0-100% outside air damper. Actuator to be provided by others.**
5. Class I motorized outside air dampers. All outside air dampers to be low leak dampers. Dampers shall have an air leakage rate not greater than 4 CFM/ sqft. and shall be labeled by an approved agency when tested in accordance with AMCA 500D.
6. **Stainless steel heat exchanger.**
7. Single point electrical power entry through bottom of unit inside curb perimeter.
8. Cabinet: Galvanized Steel, enamel paint, all sides & edges.
9. Hinged service doors.
10. Top of cabinet to be one piece, level, no step downs.
11. Unit to be completely wired, piped, etc.
12. Designated location to install electrical disconnect
13. **Fused disconnect provided by electrical contractor. Do not install fused disconnect on any access panels or over unit information tag(s).**
14. All sides shall be enclosed. All access panels shall be metal.
15. R-410A refrigerant.
16. Comply with ASHRAE 62.
17. Comply with NFPA 90A.
18. Condensate drain pan **with float switch**
19. All unit components to be U.L. listed.

I. Accessories:
1. 2-Stage Compressor Unit:
    a. All rooftop units with two stage compressors are to have a minimum of two fan speeds. In first stage cooling, the compressor is to be in first stage, and the fan is to be set to low speed. In second stage cooling, the compressor is to be in second stage, and the fan is to be set to high speed. Set differential temperature between first stage cooling and second stage cooling at 2°F (adj.).
2. Unit with Economizer Module and Fault Detection and Diagnostics.
    a. All cooling only units are to be provided with a dry bulb economizer. When outdoor dry bulb conditions are met, and the space temperature sensor is calling for cooling, the economizer mode of the unit shall provide free cooling to the space.
    b. All units 3 tons and above are to be provided with a dry bulb economizer. When outdoor dry bulb conditions are met, and the temperature sensor is calling for cooling, the economizer shall provide free cooling to the space. The dehumidification cycle and heating modes shall be disabled during economizer mode.
    c. All units 10 tons and above are to be provided with a dry bulb economizer and a power exhaust fan. The powered exhaust fan shall only be enabled during economizer mode.
    d. All economizers must be equipped with fault detection and diagnostics. The unit shall be capable of reporting faults to a fault management application system or displayed on the zones thermostat. The fault detection system shall be capable of detecting the following faults:
        (1) Air temperature sensor failure.
        (2) Not economizing when the unit should be economizing.

(3) Economizing when the unit should not be economizing.
(4) Dampers not modulating.
(5) Excess outdoor air.

J. Other
1. Furnish crankcase heaters, timed off control, freeze thermostats, low ambient to 45°F, high pressure switch and expansion valves on all units.
2. Provide extra set of filters MERV 8, pleated 2" thick.
3. List all accessories available for units and identify which accessories are being provided in submittals.

K. See Specification Section 23 05 32 for roof curb requirements.

PART 3 EXECUTION

3.1 INSTALLATION

A. Contractor is not to open refrigeration system to install accessories.

B. Install in accordance with all manufacturer's instructions and requirements.

C. Install all units so that they are LEVEL on curbs.

3.2 IDENTIFICATION

A. Provide identification per Section 23 05 53.

3.3 EQUIPMENT START UP

A. Follow all manufacturers' directions.

B. **Equipment manufacturer to provide start-up.**

C. **Start-up by contractor will not be allowed.**

D. Equipment manufacturer/supplier to provide equipment performance checkout with contractor and provide report to Engineer.

E. Make wiring changes as required to control transformer to accommodate job voltage.

F. Provide 1" roll filter media on each return air opening during construction if blower is operational. Replace as required.

G. Start-up Data and Report:
1. Follow all manufacturers' directions and requirements.

H. Measure:
1. Outside air temperature, entering and leaving conditions of evaporators and condensers, compressor amps, indoor blower amps, gas pressure, pressure drop across evaporator coil.
2. Operate all units in heating and cooling modes with make-up air units operating.
3. Provide start-up report with final request for payment.
4. Install new, clean MERV 8 - 2" thick filters prior to test and balance.

I. Test and Balance:
   1. Coordinate with Test and Balance Contractor after units are started.

END OF SECTION

SECTION 23 81 26

SPLIT SYSTEM HVAC UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Split system HVAC units.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

C. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

D. Section 23 09 13 - Programmable Control Devices for HVAC

E. Section 23 09 23 - Energy Management Control System

F. Section 23 23 00 - Refrigerant Piping

G. Section 23 31 13 - Metal Ductwork

1.4 REFERENCES

A. Refer to Section 23 00 00 for complete names of references identified in this section.

AGA	American Gas Association
AHRI 210/240	Unitary Air-Conditioning and Air Source Heat Pump Equipment
AHRI 270	Sound Rating of Outdoor Unitary Equipment
ANSI/ASHRAE 15	Safety Code of Mechanical Refrigeration
ASHRAE90.01-2001	Energy Standard for Buildings Except Low Rise Residential Buildings
ASHRAE 62-2001	Ventilation for Acceptable Indoor Air Quality
D.O.E.	Department of Energy
IECC	International Energy Conservation Code
NFPA 70 N.E.C.	National Electrical Code
UL	Underwriters Laboratory

1.5 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 1.

B. Submittals shall include:
   1. Unit model number
   2. Refrigerant type
   3. Sound rating in accordance with AHRI 270

4. Cooling efficiency in accordance with AHRI Standard 210
5. All accessories

C. Submit product data indicating typical catalog of information including arrangements.

D. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication.

E. Provide in table form a schedule similar to drawings with data listing all unit information, data, accessories, etc.

F. Indicate mechanical and electrical service locations and requirements.

G. Submit letter from air conditioning manufacturer stating refrigerant line design has been reviewed.

H. Submit manufacturer's installation instructions.

I. Shop Drawings: (adjust as required)
1. Submit 1/4" per foot shop drawing(s) showing all piping, ductwork, and equipment shown by drawings and specifications. Submit drawings on all mechanical rooms. The drawings shall be coordinated with structural, and electrical, and fire sprinkler drawings.

J. Equipment Start-up Report
1. Submit an equipment start up report as provided by the equipment manufacturer. Start-up report shall include the following, but not limited to: verification of system air flow, proper operation of all motors and fans, proper tensioning of belts and pulleys, proper operation of on-board microprocessor control system, proper control of economizer damper, proper compressor operation, and proper operation of cooling, heating, and dehumidification modes.

1.6 QUALITY ASSURANCE

A. UL listed and must display UL label on all units.

B. All units must comply with ASHRAE Standard 90.1 and the applicable International Energy Conservation Code.

C. Unit performance data must be rated in accordance with AHRI Standard 210/240, and must display the AHRI symbol on all standard units.

D. Conform to applicable ANSI/NFPA 70 code for internal wiring of factory wired equipment.

E. Air conditioning manufacturer to visit site and inspect installation of units and refrigerant lines, and provide letter stating installation conforms to installation instructions.

F. Tested in accordance with the Department of Energy.

G. The air conditioning equipment manufacturer shall be solely responsible for their equipment that does not comply with the performance of their published catalogues and specifications.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.
   1. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, including filter replacement and unit lubrication.

B. Air conditioning manufacturer to visit site and inspect installation of units and refrigerant lines, and provide letter stating installation conforms to installation instructions.

1.8 WARRANTY

A. Complete 1 year warranty on all equipment.

B. Additional 4 year warranty provided for the compressors and heat exchangers.

C. Additional 9-year warranty provided for galvanized heat exchangers.

D. Additional 14-year warranty provided for stainless steel heat exchangers.

E. The warranted compressor assembly consists of the starter, rotor, eccentric shaft, eccentric rods, pistons, wrist pins, suction valves, discharge valves, unloading mechanisms, oil pump, and the housing in which these parts are enclosed.

F. The warranty shall indicate model, serial number of the unit and commencing date. The commencing date of the warranty shall be after the building has been accepted for occupancy.

PART 2 PRODUCTS

2.1 MANUFACTURERS: HEAT PUMP

A. 1½ to 2 ½ tons - 13.0 SEER:
   1. Lennox
   2. Trane
   3. Daikin
   4. JCI

B. 3 to 5 tons - 17.0 SEER:
   1. Lennox
   2. Trane
   3. Daikin
   4. JCI
   5. Units to have two stage compressor and a minimum two speed fan.

C. 6 tons and up - High Efficiency EER:
   1. Lennox
   2. Trane
   3. Daikin
   4. JCI
   5. All units 7½ ton and larger are to have two compressors with dual refrigeration circuits.
   6. Greater than 65,000 BTU/hr and less than 135,000 BTU/hr - Minimum 11.0 EER
   7. Greater than 135,000 BTU/hr - Minimum 10.6 EER

2.2 MANUFACTURERS: GAS FURNACE

A. 1½ to 2 ½ tons - 13.0 SEER:
   1. Lennox
   2. Trane
   3. Daikin
   4. JCI

B. 3 to 5 tons - 17.0 SEER:
   1. Lennox
   2. Trane
   3. Daikin
   4. JCI
   5. Units to have two stage compressor and a minimum two speed fan.

C. 6 tons and up - High Efficiency EER:
   1. Lennox
   2. Trane
   3. Daikin
   4. JCI
   5. All units 7½ ton and larger are to have two compressors with dual refrigeration circuits.
   6. Greater than 65,000 BTU/hr and less than 135,000 BTU/hr - Minimum 11.0 EER
   7. Greater than 135,000 BTU/hr - Minimum 10.6 EER

2.3 MANUFACTURERS: ELECTRIC FURNACE

A. 1½ to 2 ½ tons - 13.0 SEER:
   1. Lennox
   2. Trane
   3. Daikin
   4. JCI

B. 3 to 5 tons - 17.0 SEER:
   1. Lennox
   2. Trane
   3. Daikin
   4. JCI
   5. Units to have two stage compressor and a minimum two speed fan.

C. 6 tons and up - High Efficiency EER:
   1. Lennox
   2. Trane
   3. Daikin
   4. JCI
   5. All units 7½ ton and larger are to have two compressors with dual refrigeration circuits.
   6. Greater than 65,000 BTU/hr and less than 135,000 BTU/hr - Minimum 11.0 EER
   7. Greater than 135,000 BTU/hr - Minimum 10.6 EER

2.4 SPLIT SYSTEM HEATING/ COOLING UNITS

A. Minimum Cooling Efficiencies:
   1. EER ratings by AHRI Standard 210/ 240 and AHRI Standard 340/360:
      a. All units to comply with ASHRAE 90.1.
      b. All units to comply with International Energy Conservation Code 2015.

B. Natural Gas Furnaces:
   1. Heating capacities:
      a. Equal to or greater than those scheduled on plans.
   2. Ignition:
      a. Equip with electronic pilot standard ignition
      b. Standing pilot not allowed
   3. Efficiency:
      a. Minimum 92% AFUE rating
   4. Heat exchanger material:
      a. Aluminized steel
      b. Bear AGA label.

C. Electric Furnaces/Air Handlers:
   1. Heating capacities:
      a. As scheduled on plans at rated voltage.
   2. Three-phase electrical power:
      a. Impose an equal electrical load on all phases of heater.
      b. Electrical resistance elements which are not balanced over all three phases are not acceptable.

D. Heat Pump Units:
   1. Features:
      a. Crankcase heaters
      b. Timed off control
      c. Low Ambient cooling to 45°F
      d. Hi/Low pressure switches
      e. Over current protection
      f. Filter Dryer
      g. Provide hail guards on all condensing units on the roof
      h. Factory installed defrost control to operate on demand
      i. Provide any reference specialties that manufacturer requires
      j. Refrigerant R-410A

E. Condensing Units:
   1. Features:
      a. Crankcase heaters
      b. Timed off control
      c. Low Ambient cooling to 45°F
      d. Hi/Low pressure switches
      e. Over current protection
      f. Filter Dryer
      g. Provide Hail Guards on all Condensing Units
      h. Provide any reference specialties that manufacturer requires
      i. Refrigerant 410-A

F. All Air Handlers:
   1. Features:
      a. 2 inch filter racks to be provided at each air handler.
      b. Easy access to filters
      c. Provide extra set of filters, Farr 3030 pleated 2” thick. MERV $\geq$ 6.0.
      d. Low voltage terminal strip
      e. All blowers shall deliver a minimum of 450 cfm/ton at .5" E.S.P.
      f. Furnish and install auxiliary drain pans below each air handler. Provide float switches for all auxiliary drain pans.

2. **Class I motorized outside air dampers. All outside air dampers to be low leak dampers. Dampers shall have an air leakage rate not greater than 4 CFM/ sqft. and shall be labeled by an approved agency when tested in accordance with AMCA 500D.**

G. Accessories:
1. 2-Stage Compressor Unit:
a. All split system units with two stage compressors are to have a minimum of two fan speeds. In first stage cooling, the compressor is to be in first stage, and the fan is to be set to low speed. In second stage cooling, the compressor is to be in second stage, and the fan is to be set to high speed. Set differential temperature between first stage cooling and second stage cooling at 2°F (adj.).
2. Unit with CO2 Sensor (Demand Controlled Ventilation):
a. Motorized, modulating outside air dampers are to be installed in outside air ductwork that connects to the return air ductwork. Dampers are to be spring closed in the unoccupied mode. CO2 sensor will provide demand control ventilation by keeping the damper in minimum position unless differential between outside CO2 levels and inside CO2 levels are greater than 700 ppm (adj.). An example if outside air CO2 level is 500 ppm, and the indoor CO2 sensor reads 1100 ppm, the damper is to modulate open to minimum position and be fully opened at 1190 ppm. All outside air is to be filtered.
3. Unit with Economizer Mode and Fault Detection and Diagnostics.
a. All cooling only units are to be provided with a dry bulb economizer. When outdoor dry bulb conditions are met, and the space temperature sensor is calling for cooling, the economizer mode of the unit shall provide free cooling to the space.
b. All units 3 tons and above are to be provided with a dry bulb economizer. When outdoor dry bulb conditions are met, and the temperature sensor is calling for cooling, the economizer shall provide free cooling to the space. The dehumidification cycle and heating modes shall be disabled during economizer mode.
c. All units 10 tons and above are to be provided with a dry bulb economizer and a power exhaust fan. The powered exhaust fan shall only be enabled during economizer mode.
d. All economizers must be equipped with fault detection and diagnostics. The motorized, modulating dampers shall be capable of reporting faults to a fault management application system or displayed on the zones thermostat. The fault detection system shall be capable of detecting the following faults:
(1) Air temperature sensor failure.
(2) Not economizing when the unit should be economizing.
(3) Economizing when the unit should not be economizing.
(4) Dampers not modulating.
(5) Excess outdoor air.
e. Economizer operation, fault detection, and control shall be the responsibility of the controls contractor. There shall be no interlock between the Energy Management Control System and the unit's integral controls in regard to economizer operation. (i.e. Honeywell JADE Controllers are not allowed.)
f. The motorized, modulating outside air damper(s) and motorized return air damper(s) shall be provided and installed by the mechanical contractor. The controls contractor shall provide the 0-100% actuator to control the motorized, modulating outside air damper and the actuator to control the motorized damper in the return section.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with the plans, manufacturer's instructions and approved shop drawings.

B. Contractor to provide and install thermostat wire from air handler to condensing units.

C. Contractor to provide and install flexible watertight conduit for wiring.

D. Coordinate with plumbing contractor on all condensate piping.

E. Install roll type filter media over all return air openings during construction if unit is operated. Replace as required.

F. Accessories:
   1. Unit with CO2 Sensor (Demand Controlled Ventilation):
      a. Motorized, modulating outside damper to open to minimum position when fan is ON, and spring return close when fan is OFF. All dampers are to modulate with call from CO2 sensors. All outside air to be filtered.

3.2 IDENTIFICATION

A. Provide identification per Section 23 05 53.

3.3 EQUIPMENT START UP

A. Equipment manufacturer to provide start-up.

B. Install and make hook-up to float switches.

C. Measure:
   1. Outside air temperature, entering and leaving conditions of evaporators and condensers, compressor amps, indoor blower amps, gas pressure, pressure drop across evaporator coil.
   2. Operate all units in heating and cooling modes with outside air in operation.
   3. Provide report with final request for payment.
   4. Install new, clean filters prior to test and balance.
   5. Provide connection to refrigeration piping system and evaporators.

END OF SECTION

SECTION 23 81 27

SMALL CAPACITY SPLIT SYSTEM UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Split system cooling units for elevator machine rooms, electrical rooms, MDF and IDF Rooms as noted in schedule and shown on drawings.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

C. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

D. Section 23 09 13 - Programmable Control Devices for HVAC

E. Section 23 09 23 - Energy Management Control System

F. Section 23 23 00 - Refrigerant Piping

G. Section 23 31 13 - Metal Ductwork

1.4 REFERENCES

A. Refer to Section 23 00 00 for complete names of references identified in this section.

B. ARI 210/240 - Unitary Air-Conditioning and Air Source Heat Pump Equipment

C. ARI 270 - Sound Rating of Outdoor Equipment

D. ARI 270 - Sound Rating of Outdoor Unitary Equipment

E. ANSI/ASHRAE 15 - Safety Code of Mechanical Refrigeration

1.5 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 90, General Conditions, and Division 1.
   2. Submittals shall include:
      a. Unit model number
      b. Refrigerant type
      c. Sound rating in accordance with ARI 270
      d. Cooling efficiency in accordance with ARI Standard 210
      e. All accessories

3. Submit product data indicating typical catalog of information including arrangements.
4. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication.
5. Indicate mechanical and electrical service locations and requirements.
6. Submit manufacturer's refrigerant piping.
7. Submit manufacturer's installation instructions.

B. Shop Drawings: (adjust as required)
1. Submit 1/4" per foot shop drawing(s) showing all piping and equipment shown by drawings and specifications. Submit drawings on all mechanical rooms. The drawings shall be coordinated with structural, and electrical, and fire sprinkler drawings.

1.6 QUALITY ASSURANCE

A. UL listed and must display UL label on all units.

B. Unit performance data must be rated in accordance with ARI Standard 210/240, and must display the ARI symbol on all standard units.

C. Conform to applicable ANSI/NFPA 70 code for internal wiring of factory wired equipment.

D. Manufacturer to size refrigerant lines.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, including filter replacement and unit lubrication.

1.8 WARRANTY

A. Complete 1 year warranty on all equipment

B. Additional 5 year warranty provided for the compressors and heat exchangers.

C. The warranted compressor assembly consists of the starter, rotor, eccentric shaft, eccentric rods, pistons, wrist pins, suction valves, discharge valves, unloading mechanisms, oil pump, and the housing in which these parts are enclosed.

D. The warranty shall indicate model, serial number of the unit and commencing date. The commencing date of the warranty shall be after the building has been accepted for occupancy.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Daikin

B. Mitsubishi

C. LG

D. Lennox

E. Samsung

2.2 CONDENSING UNITS

A. Features:
1. Crankcase heaters
2. Timed off control
3. Low Ambient to 50°F
4. Hi/Low pressure switches
5. Over current protection
6. Filter Dryer

2.3 CONTROLS

A. Controller Features:
1. Manually activated “dry” mode. Low speed indoor fan, high speed compressor.
2. Temperature Settings/Display
3. 24 Hour Timer
4. Fan Speed Indicator
5. Mode Settings (auto, cool/dry)
6. EMCS Gateway via RS-232 Terminal

2.4 ALL AIR HANDLERS

A. Features:
1. Easy access to filters
2. Low voltage terminal strip
3. All blowers shall deliver a minimum of 450 cfm/ton at .5" E.S.P.
4. Filter racks to be provided in each air handler.
5. Condensate pump

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with the plans, manufacturer's instructions and approved shop drawings.

B. Both suction and liquid lines are to be insulated.

3.2 IDENTIFICATION

A. Provide identification per Section 23 05 53.

3.3 EQUIPMENT START UP

A. Provide start-up.
1. Start-up Data and Report:
a. Follow all manufacturers’ directions.

B. Measure:
1. Outside air temperature, entering and leaving conditions of evaporators and condensers, compressor amps, indoor blower amps, gas pressure, pressure drop across evaporator coil.
a. Operate all units in heating and cooling modes.

b. Provide report with final request for payment.
c. Install new, clean filters. Cover return air with filter media until construction is complete.
d. Provide connection to refrigeration piping system and evaporators.
e. Do not install condensate pumps over any equipment panels.
f. Condensate pumps are to operate any time the unit is in the cooling mode and water is in drain pan. Follow manufacturer's instructions.

END OF SECTION

SECTION 23 81 46

WATER SOURCE HEAT PUMP UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Water source heat pump units.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

C. Section 23 09 23 - Energy Management Control System

D. Section 23 31 13 - Metal Ductwork

1.4 REFERENCES

A. ARI 270 - Unitary Air Conditioning Equipment

B. ARI 210 - Sound Rating Unitary Equipment

C. U.L. - Underwriter’s Laboratories

D. ASHRAE - American Society Heating Refrigeration Air Conditioning Engineers

E. ARI 320 - Water Source Heat Pump Equipment

F. ANSI/UL 559 - Standard for Heat Pumps

G. NFPA 90A - Installation of Air Conditioning & Ventilating Systems

1.5 WARRANTY

A. Units shall have a warranty by the manufacturer against defects in material and workmanship for a period of one year on all parts. The compressor shall have a warranty for a period of five years. Provide one year parts and labor warranty for the entire unit.

1.6 SUBMITTALS

A. Product Data:
   1. Provide submittal data on all equipment specified in this section in accordance with Section 23 00 00, General Conditions, and Division 1.

B. Submittals shall include:
   1. Unit model number

2. Refrigerant type
3. Sound rating in accordance with ARI 270
4. Cooling efficiency in accordance with ARI Standard 210
5. All accessories

C. Submit product data indicating typical catalog of information including arrangements.

D. Submit product data sheets indicating dimensions, general assembly, and materials used in fabrication.

E. Provide in table form a schedule similar to drawings with data listing all unit information, data, accessories, etc.

F. Indicate mechanical and electrical service locations and requirements.

G. Submit manufacturer's installation instructions.

H. Shop Drawings: (adjust as required)
1. Submit 1/4" per foot shop drawing(s) showing all piping, ductwork, and equipment shown by drawings and specifications. Submit drawings on all mechanical rooms. The drawings shall be coordinated with structural and electrical.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data at close-out.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site per manufacturer's standard terms and conditions.

B. Store and protect products per manufacturer's recommendations.

C. Protect products from physical damage by leaving factory packing cases in place before installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Daikin

B. Aaon

C. Trane

D. Florida Heat Pump

E. Water Furnace

F. Climatemaster

2.2 HORIZONTAL/ VERTICAL WATER SOURCE HEAT PUMPS

A. Units shall be designed to operate throughout the range of entering fluid temperature of 50°F to 100°F. Equivalent units from other manufacturers can be proposed provided approval to bid is given 10 days prior to bid. All equipment in this section with a nominal capacity of 134,000 BTUH Total Cooling or lower must be listed in the current ARI Applied Equipment Directory under the ARI Standard ARI-ISO-13256-1, WLHP Rating. All equipment in this section with a nominal capacity greater than 134,000 BTUH Total Cooling shall be rated in accordance to ARI Standard ARI-ISO-13256-1, WLHP Rating with published submittal performance from the manufacturer. All equipment in this section must meet or exceed the national standard minimum EER and COP as listed in ASHRAE 90.1-1999 for the ARI-ISO-13256-1, WLHP Rating (12.0 EER and 4.2 COP for units larger than a nominal 17,000 BTUH Total Cooling - 11.2 EER and 4.2 COP for units below a nominal 17,000 BTUH Total Cooling). All units shall be listed with Underwriters Laboratories (UL). All units shall have ARI-13256-1 labels, and UL labels.

2.3 BASIC CONSTRUCTION

A. Units shall have the air flow arrangement as shown on the plans. If units with these arrangements are not used, the contractor supplying the water source heat pumps is responsible for any extra costs incurred by other trades and must submit detailed mechanical drawings showing ductwork requirements and changes or relocation of any other mechanical or electrical system. If other arrangements make servicing difficult the contractor must provide access panels and clear routes to ease service.

B. All units shall have stainless steel drain pans or molded plastic drain pans.

C. All water source heat pumps shall be fabricated from heavy gauge galvanized sheet metal. All interior surfaces shall be lined with 1/2-inch thick, multi density acoustic insulation. All insulation must meet NFPA 90A. One blower access panel and two compressor compartment access panels shall be removable with supply and return air ductwork in place.

D. All units shall have a factory installed 2-inch thick filter bracket for use with standard 2-inch filters. Units shall have a 2-inch thick throwaway type glass fiber filter. The contractor shall purchase one spare set of filters and replace factory-shipped filters upon completion of start-up.

E. Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. Supply and return water connections shall be brass FPT fittings and shall be securely mounted flush to the cabinet allowing for connection to a flexible hose without the use of a back-up wrench. Water connections, which protrude through the cabinet, shall not be allowed.

2.4 FAN AND MOTOR ASSEMBLY

A. Units with a nominal rating of 70,000 BTUH and under shall have a direct-drive centrifugal fan. The fan motor shall be 3-speed, permanently lubricated, PSC type with thermal overload protection. The fan motor shall be isolated from the fan housing by torsionally flexible isolation.

B. Units with a nominal rating of 72,000 BTUH Total Cooling and above shall have a belt drive fan assembly. The assembly shall include a forward curved fan wheel, housing, solid steel fan shaft encased in ball bearings, fan pulley and adjustable motor sheave. The motor shall have internal thermal overload protection. The motor shall be mounted on an adjustable base for proper belt tension.

C. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. External static pressure rating of the unit shall be based on a wet coil. Ratings based on a dry coil shall NOT be acceptable.

2.5 FILTERS

A. Provide 2” filter racks and extra sets of 2” pleated filters.

2.6 REFRIGERANT CIRCUIT

A. Units shall have a factory sealed and fully charged refrigerant circuit with the following components. All units with a nominal rating of 72,000 BTUH Total Cooling and above shall have two independent refrigerant circuits with the following components:
   1. A hermetic compressor: Hermetic compressors shall be internally sprung, externally isolated, with thermal overload protection and shall be located in an insulated compartment to minimize sound transmission
   2. Refrigerant metering capillary tubes or thermal expansion valve
   3. A finned tube refrigerant to air heat exchanger not exceeding 14 fins per inch. Refrigerant to air heat exchangers shall utilize enhanced aluminum fins and rifled copper tube construction rated to withstand 450 PSIG refrigerant working pressure. Equipment submitted with air coils, which exceed 14 fins per inch, must be supplied with 60% efficient filters in place of standard filters and this additional external static pressure must be calculated and submitted by the contractor and added to the scheduled static pressure to determine compliance.
   4. Reversing valves shall be four-way solenoid activated refrigerant valves which shall fail to the heating operation should the solenoid fail to function.
   5. The water-to-refrigerant heat exchanger shall be of a high quality coaxial coil for maximum heat transfer. The copper coil is deeply fluted to enhance heat transfer and minimize fouling and scaling. The coil has a working pressure of 400 psig on both the refrigerant and water side. The factory shall provide rubber isolation to the heat exchanging device to enhance sound attenuation.
   6. Safety controls including a high-pressure switch and a low-pressure switch. Temperature sensors shall not replace these safety switches. See the controls section of this specification for additional information.
   7. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service.
   8. Activation of any safety device shall prevent compressor operation via a lockout circuit. The lockout circuit shall be reset at the thermostat or at the contractor supplied disconnect switch. Units which may be reset at the disconnect switch only shall not be acceptable.

2.7 ELECTRICAL

A. A control box shall be located within the unit and shall contain a transformer, controls for the compressor, reversing valve and fan motor operation and shall have a terminal block for low voltage field wiring connections. The transformer shall be rated for a minimum 50 VA for single compressor units and 100 VA for dual compressor units. All units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 volts.

2.8 SOLID STATE SAFETY CIRCUIT

A. All units shall have a solid-state CCM safety control circuit with the following features:
   1. Anti-short cycle time delay on compressor operation
   2. Random start on power up mode
   3. Brown out/Surge/Power Interruption protection
   4. Low Pressure Switch 90 second bypass timer

5. Shutdown on high or low refrigerant pressures safety switch inputs
6. Alarm output which closes for 24VAC remote fault indication
7. Reset unit at thermostat or disconnect
8. Automatic intelligent reset. Unit shall automatically reset the unit after a safety shut down and restart the unit after the anti-short cycle timer and random start timer expire. Should a fault re-occur within 10 minutes after reset, then a permanent lockout will occur.
9. Ability to defeat time delays for servicing
10. A light emitting diode (LED) to indicate high pressure or low-pressure fault status. The LED will display either fault condition as soon as the fault occurs. During the intelligent reset routine as described above, the original fault is displayed for one hour. If a fault does not occur again within that one hour, then the fault memory is cleared. If a fault does occur again, then a permanent lockout will occur and the fault LED will display the type of fault until the unit is reset.
11. UL listed, RFI, ESD, and transient protected.

2.9 HOT GAS REHEAT

A. For units as noted on the schedule, supply each unit with a UL listed, full size hot gas reheat coil located downstream of the standard refrigerant to air heat exchanger. Each unit shall have a 24V solenoid to control the reheat mode from a standard humidistat. Each hot gas reheat coil shall be sized to reheat the supply air a minimum of 95% of the sensible cooling capacity of the water source heat pump over the entire operating range.

2.10 HOSE KITS

A. All units 120,000 BTUH and below shall be connected with hoses. The hoses shall be 2 feet long, braided stainless steel, fire rated hoses complete with adapters. Non-fire rated hoses are not acceptable. Hose kits shall be as manufactured by Hays Fluid Controls and contain automatic flow balancing device, Y-strainer, isolation ball valves and pressure/temperature test ports. All applicable flow control valves, temperature control valves, etc. shall also be provided with hose kits.

2.11 IDENTIFICATION

A. Provide identification per Section 22 05 54.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that required utilities are available, in proper location, and ready for use.

C. Beginning of installation means installer accepts existing surfaces.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Locate units as indicated, level and shim units, and anchor to structure.

C. Protect units with protective covers during balance of construction.

D. Properly trap all units.

3.3 CLEANING

A. Clean work.

B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials available from manufacturer.

D. Install new filters.

E. Test in heating and cooling modes prior to calling test and balance contractor.

3.4 EQUIPMENT START UP

A. Provide start-up.
   1. Make wiring changes as required to control transformer to accommodate job voltage.
   2. Provide 1” roll filter media on each return air opening during construction.

B. Start-up Data and Report:
   1. Follow all manufacturers’ directions.

C. Measure:
   1. Outside air temperature, entering and leaving conditions of evaporators and condensers, compressor amps, indoor blower amps, gas pressure, pressure drop across evaporator coil.

D. Operate all units in heating and cooling modes with make-up air units operating.

E. Provide report with final request for payment.

F. Install new, clean Farr 30/30-2” thick filters prior to test and balance.

G. Test and Balance:
   1. Coordinate with Test and Balance Contractor after units are started.

H. Install in accordance with the plans and manufacturer’s instructions.

END OF SECTION

SECTION 23 82 19

FAN COIL UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Hydronic fan coil units with hydronic heating or electric heating.

1.3 RELATED WORK

A. Section 22 05 30 - Pipe and Pipe Fittings

B. Section 23 00 00 - Basic Mechanical Requirements

C. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

D. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

E. Section 23 09 23 - Energy Management Control System

F. Section 23 21 13 - Hydronic Piping, Valves, and Appurtenances

1.4 REFERENCES

A. Air - Air Conditioning Refrigeration Institute

B. UL - Underwriters Laboratory

C. NFPA - National Fire Protection Association

D. ANSI - American National Standards Institute

E. ASTM - American Standard and Test Materials

1.5 SUBMITTALS

A. Submit shop drawings and product data sheets indicating cross section of cabinets, general assembly, and materials used in fabrication.

B. Submit product data indicating typical catalog of information including arrangements, dimension, ratings, etc.

C. Indicate mechanical and electrical service locations, clearances and requirements.

D. Submit manufacturer's installation instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, including filter replacement and unit lubrication.

1.7 REGULATORY REQUIREMENTS

A. UL listed and labeled.

B. Unit performance data must be rated in accordance with ARI Standard 440, and must display the ARI Symbol on all standard units.

C. Conform to applicable ANSI/NFPA 70 code for internal wiring of factory wired equipment.

1.8 HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from damage. Leave factory shipping covers in place until installation.

1.9 WARRANTY

A. Provide a full parts and labor warranty for one year from completion date.

PART 2 PRODUCTS

2.1 MANUFACTURERS - FAN COIL UNITS

A. Carrier

B. Daikin

C. Trane

D. Magic Aire

E. ETI

F. Price

G. Titus

H. VTS

I. Substitutions:
   1. Any manufacturer desiring to furnish equipment for this project, who is not listed above shall provide complete submittal data as outlined above, ten (10) days prior to the bid date. Sales literature and general catalog data will not be acceptable. If a manufacturer is deemed acceptable to bid, the name/model number of that manufacturer will be listed by addenda. If the manufacturer is not listed herein or by addenda they will NOT be acceptable. Additionally, listing herein or by addenda does not alleviate the contractor from furnishing equipment which meets the letter and the intent of this specification.

2.2 FAN COIL CONSTRUCTION

A. Hydronic Coils:
1. Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 283 psi and 275°F.
2. Construct tubes of 3/8 inch O.D. minimum, 0.014 inch wall thickness copper, and construct fins of aluminum. Coils shall be capable of being rotated in the field for right or left-hand connection.

B. Electric Heating Coils:
1. Factory-wired and installed one or two stage electric heating coil with over-temperature protection and magnetic contactors. All heaters 5 kW and higher shall be furnished with two (2) stage heating control. Secondary manual reset backup protection provided as well as selection between mercury/magnetic contactors available. A single point power connection shall be provided for power to the electric heater and the fan motor. Electric heat capacity shall be as scheduled on the contract documents. The voltage and phase shall be as shown on the electrical drawings, if there is a discrepancy. The contractor (mechanical and/or electrical) shall advise the engineer of any discrepancies between the equipment schedule and the electrical drawings prior to the bid date.

C. Factory Piping Package:
1. Unit manufacturer shall provide piping package factory assembled and shipped loose for field installation. Control valves shall be selected with a valve flow coefficient providing a wide open water pressure drop of the selected coil. Two-way or three-way piping packages shall be available. The contractor shall provide the interconnecting piping between the piping package and the coil. The contractor shall completely insulate the piping package with the same insulation material as the chilled water piping and per the insulation specifications. The contractor shall fabricate an auxiliary drain pan under the piping package, with drain connection and piping.
a. Two-way piping packages shall include the following component connected in the direction of water flow:
(1) Supply ball valve
(2) Strainer
(3) Two-way modulating, not two (2) position control valve
(4) Circuit balancing valve
b. Three-way piping packages shall include the following component connected in the direction of flow:
(1) Supply ball valve
(2) Strainer
(3) Balance fitting
(4) Three-way modulating, not two position, mixing controls valve
(5) Circuit balance valve

D. Drain Pan:
1. Provide a positively sloped, non-corrosive drain pan under cooling coil. Acceptable materials include ABS plastic, 304 stainless steel or galvanized steel.

E. High Capacity Filter Section:
1. Provide filter section with maximum filter face velocity of 300 at design airflow. Filter section shall utilize standard size filters. Filter access panels shall be provided on both sides of unit. Two inch filter rack to be provided for each fan coil unit. Filter rack to be installed at fan coil unit to allow outside air and return air to be filtered by one, easily removable two-inch thick throwaway filter. All units shall use standard filter sizes. Two (2) sets of pleated media filters shall be provided. At a minimum one (1) set of filters shall be used during construction and a second set shall be installed prior to final air balance. In

the event the filters get dirty during construction, the Engineer can advise the contractor to change the filter media, at the contractor's expense.

F. Cabinet:
1. Construction shall be 18 gauge, including framing, top panels, side panels and front panels with exposed corners and edges rounded, easily removed panels.

G. Discharge Arrangements:
1. Concealed units shall have integral duct collar outlet.

H. Cabinet Insulation:
1. Acceptable cabinet insulation shall include:
a. Closed cell insulation. The exposed side shall be high density erosion proof material suitable for use in airstreams up to 4500 FPM.
b. Fiberglass Insulation. Interior surface of unit casing is acoustically and thermally lined with a minimum of 1 inch, 1.5 lb./cu. ft. Tufskin fireproof and odorless fiberglass insulation. Meets NFPA-90A, UL 181 and bacteriological standard ASTM C 665.

I. Insulation shall meet the following Underwriters' Laboratories Fire Hazard Classification:
1. Flame Spread = 20
2. Fuel Contributed = 15
3. Smoke Developed = 0

J. Finish:
1. Cabinets shall be galvanized.

K. Fans:
1. Direct drive
2. Centrifugal forward-curved double-width, double-inlet corrosion resistant wheels, statically and dynamically balanced. Fans shall be in the DRAW through configuration. 1.2 service factor.

L. Motor:
1. ECM, resiliently mounted, factory run tested with integral thermal overload protection. Motor shall be factory installed and wired to the air handler junction box.

M. Mixing Box Section:
1. Provide a mixing box section for economizer control. Heavy gauge low leak damper blade with bladed and jamb seals shall be used. Damper shall be factory linked together and use a double ended drive rod which allows for field mounting of actuator on inside or outside of unit right or left side. Access panels shall be provided on both sides of unit. Mixing box shall be capable of varying proportion of mixed air from 100 percent room air to 100 percent outside air.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that required utilities are available, in proper location, and ready for use.

C. Beginning of installation means installer accepts existing surfaces.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install fan-coil units as indicated. Coordinate to assure correct recess size for recessed units.

C. Protect units with protective covers during balance of construction.

D. Provide float operated automatic air vents with stop valve on all coils.

E. Provide auxiliary drain pans with overflow drain properly routed.

3.3 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials available from manufacturer.

C. Install new filters prior to final test and balance.

D. Flush the entire system of all cutting oil, slag, pipe debris using a 1-2% solution of sodium triphosphate. All fan coil unit hoses shall be connected such that flow bypasses the cooling and heating coils, automatic flow control valves and the control valves during this process. After the system is properly cleaned the contractor shall properly connect the fan coil units and blow down all the strainers.

END OF SECTION

SECTION 23 82 39

ELECTRIC UNIT HEATERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 23 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Electric unit heaters.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements

B. Section 23 09 23 - Energy Management Control System

1.4 REFERENCES

A. UL - Underwriters Laboratories and Bear Label

B. NEC - National Electric Code

1.5 SUBMITTALS

A. Provide submittal data on all items specified in this section in accordance with Specification Section 23 00 90, General Conditions, and Division 1.

B. Submit product data with ratings, capacities, electrical connections, etc.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Berko

B. Indeeco

C. Markel

D. Qmark

E. Redd-i

F. Trane

2.2 GENERAL

A. Provide electric unit heater with capacity, horsepower, and motor voltage as shown on schedule.

2.3 FEATURES

A. Draw through design.

B. Fan and limit safety controls.

C. Supply voltage as shown on drawings.

D. 24 Volt transformer and terminal block.

E. All elements 80/20 nichrome wire and copper clad steel sheath.

F. Automatic reset thermal overloads - instantaneous de-energizing.

G. Fan guard.

H. Mounting brackets.

I. Horizontal directional louvers.

J. Threaded suspension couplings (2, 1" ISP).

K. Baked enamel finish. Cabinet 18 ga. baked enamel finish.

L. Manual summer winter switch on thermostat base with relay.

M. Units to bear UL listing and meet NEC requirements.

2.4 MOTORS

A. Totally enclosed, designed for continuous duty, built-in overload protection.

B. 25 kW and larger to have 2-speed motors.

C. Heaters that draw 48 amps or greater shall be provided with factory installed, subdivided and fused circuits.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's instructions and locations shown on plans.

B. Install for service access to any electrical control panel, etc.

3.2 IDENTIFICATION

A. Per Section 23 05 53.

END OF SECTION

ELECTRICAL

DIVISION 26

26 00 00	Electrical
26 00 30	Warranty Period
26 00 90	Electrical Submittal Procedures
26 05 11	Electrical Demolition
26 05 19	Low-Voltage Electrical Power Conductors and Cables
26 05 26	Grounding and Bonding for Electrical Systems
26 05 33.11	Raceways and Conduits for Electrical Systems
26 05 33.13	Boxes and Fittings for Electrical Systems
26 05 53	Identification for Electrical Systems
26 24 16	Panelboards for Distribution Switchgear
26 27 26	Wiring Devices
26 28 13	Fuses
26 28 16	Enclosed Safety Switches and Circuit Breakers
26 43 00	Surge Protective Devices (SPD)

SECTION 26 00 00

ELECTRICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Bidding requirements, contract forms, conditions of the contract, Division 1 - General Requirements apply to work of this division.

1.2 SECTION INCLUDES

A. Furnishing of all materials, equipment, tools, scaffolding, labor and transportation required for the complete installation of the electrical systems as shown on the drawings and as specified herein.

B. Bidders shall determine the contents of a complete set of drawings and specifications and be aware that they may be bidding from a partial set of drawings, applicable only to the various separate contracts, subcontracts, or trades as may be issued for bidding purposes only. The contract documents and the complete scope of work for the project are illustrated on the combined Architectural, Structural, Plumbing, Heating, Ventilating, Air Conditioning and Electrical, and each Bidder shall thoroughly acquaint himself with all the details of the complete set of drawings and specifications before submitting his bid. All drawings and specifications form a part of the contract documents for each separate contract and shall be considered as bound therewith in the event partial sets of plans and specifications are issued for bidding only. The submission of bids shall be deemed evidence of the review and examination of all drawings, specifications, and addenda issued for this project as no allowances will be made because of unfamiliarity with any portion of the complete set of documents.

C. It is the intent of these specifications to provide complete installations even though each and every item necessary is not specifically mentioned or shown. In general, the work specified in this section shall consist of, but is not limited to, the following:
   1. Electrical demolition.
   2. Systems of raceways, conductors, cables, boxes, receptacles, wiring devices, and cover plates.
   3. Relays, wiring, devices, contactors, conduit and other required equipment for all systems and details shown on the electrical drawings.
   4. Electrical identification.
   5. Surge Protective Devices (SPDs)
   6. Utility services, utility requirements, including conduit and coordination.
   7. Switchgear including switchboards and panelboards.
   8. Secondary electrical service and distribution system including wiring.
   9. Luminaires, LED modules and drivers.
   10. Coordination (including voltage, phase, ampacity, etc.) and final connection to all line voltage systems or equipment provided under other divisions or by owner.
   11. Testing of wire and cable installation.
   12. Submittals and shop drawings.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Control wiring of HVAC and related equipment as specified in other sections.

B. Motor starters required on HVAC and related equipment as specified in other divisions and sections.

1.4 REFERENCES

A. On projects where the engineer is the prime consultant and no architect is involved, any references to the architect or to architectural drawings in the Division 26 specifications shall be interpreted as referring to the engineer or to the engineering drawings.

1.5 CODES, STANDARDS AND THEIR ABBREVIATIONS

A. Perform all Division 26 work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are modified by the contract documents.

B. In addition to the requirements outlined in other sections of the specifications the following standards are imposed as applicable to the work in each instance:
   1. NECA standards for installation.
   2. NFPA No. 70, National Electric Code.
   3. Local Codes and Ordinances.
   4. COG Standard Specifications for Public Works Construction.
   5. Title 25, Health Services, Part 2, Texas Department of Health, Chapter 145, Long Term Care Subchapter Q.
   6. OSHA Standard 2207 - Construction Industry Standard
   7. OSHA 29 CFR 1926 - Regulation of Excavation
   8. Texas Underground Facility Damage Prevention Act (H.B. 2295)

C. Where local codes or practices exceed or conflict with the NEC, it shall be the Contractor's responsibility to perform the work in accordance with the local code prevailing and local interpretations thereof. Any such additional work shall be performed at no additional cost to the Owner.

D. Materials and components shall be UL listed and approved for the purpose intended.

E. The Contractor shall obtain all permits required to commence work and, upon completion of the Work, obtain and deliver to the Owner's Representative a Certificate of Inspection and Approval from the State Board of Fire Underwriters, the City of Mount Pleasant, Texas and other authority having jurisdiction. The Contractor shall pay required permit fees.

1.6 LIST OF ASSOCIATIONS AND STANDARDS

A. The following abbreviations are applicable for this entire division.
   1. ANSI - American National Standards Institute, 1430 Broadway; New York, NY 10018.
   2. ASTM - American Society for Testing and Materials, 1916 Race Street; Philadelphia, PA 19103.
   3. IEEE - Institute of Electrical and Electronics Engineers, 345 East 47th Street; New York, NY 10017.
   4. ICEA - Insulated Cable Engineers Association, P.O. Box P; South Yarmouth, MA 02664.
   5. NEC - National Electrical Code; NFPA No. 70.
   6. NECA - National Electrical Contractors Association, Inc., 7315 Wisconsin Ave.; Washington, DC 20014.
   7. NEMA - National Electrical Manufacturers Association, 155 East 44th Street; New York, NY 10017.
   8. NESC - National Electrical Safety Code, ANSI 2.
   9. NFPA - National Fire Protection Association, 60 Batterymarch Street; Boston, MA 02110.
   10. OSHA - Occupational Safety and Health Administration, US Department of Labor; Washington, DC 20402.
   11. UL - Underwriters Laboratories, Inc., 333 Pfigsten Road; Northbrook, IL 60062.

B. Nothing in the Contract Documents shall be construed to permit work not conforming to these codes. When two or more codes or standards are applicable to the same work, then the stricter code or standard shall govern.

C. The date of the code or standard is that in effect on the date of issue of the contract documents except when a particular publication date is specified.

D. This Contractor shall comply with all State, Federal, NFPA, local codes and ordinances that may alter any part of the plans or specifications. This Contractor shall bear all costs for correcting any deficiencies due to non-compliance.

E. Where local codes and ordinances are not in writing or on record but a local precedence has been set, the Owner shall pay for any additional resulting cost.

1.7 DEFINITIONS

A. Approval: It is understood that approval must be obtained from the Architect in writing before proceeding with the proposed work. Approval by the Architect of any changes, submitted by the Contractor, will be considered as general only to aid the Contractor in expediting his work.

B. Directed: Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.

C. Furnish: The term furnish means to equip with what is needed, supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

D. Install: The term install describes operations at the Project site including setting in position, connecting on adjusting for use, the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

E. Provide: Defined as requiring the furnishing, supplying, to make available, and installation of the item or facility indicated, complete in all respects and ready for operation unless otherwise specifically noted.

F. Indicated: The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.

1.8 ABBREVIATIONS FOR ELECTRICAL DRAWINGS

A	Amperes
ALT	Alternate
AFF	Above finish floor
AFG	Above finished grade
AWG	American wire gauge
ATS	Automatic transfer switch
CLG	Ceiling
CKT	Circuit
CCTV	Closed circuit television
DFA	Down from above
DISC	Disconnect
EWC	Electric water cooler
EXIST	Existing
FAP	Fire alarm plan

FACP	Fire alarm control panel
FAGA	Fire alarm graphic annunciator
FARA	Fire alarm remote annunciator
FPC	Fire protection contractor
GRN	Ground
GFCI	Ground-fault circuit interrupters
GFP	Ground-fault protection
HP	Horsepower
HPS	High pressure sodium
KW	Kilowatts
KES	Kitchen equipment supplier
MTS	Manual transfer switch
MH	Metal Halide
MCC	Motor control center
NC	Normally closed
NO	Normally open
NTS	Not to scale
NIC	Not in contract
PNL	Panel
SFD	Smoke/Fire Damper
SU	Stub up above finish floor
SWBD	Switchboard
TV	Television
TX	Transformer
TYP	Typical

1.9 NEMA CLASSIFICATIONS

A. For complete definitions and listing see NEMA Standards.

Type 1	General Purpose, Indoor.
Type 2	Drip-proof, Non corrosive, Indoor.
Type 3R	Rain proof, Outdoor.
Type 4	Watertight and dust tight, Non corrosive. Indoor and outdoor.
Type 4X	Watertight and dust tight, Corrosion resistant. Indoor and outdoor.
Type 12	Dust tight, Drip-tight, Non corrosive, Indoor. See NEC 2008 110.22 FPN.

1.10 PROJECT/SITE CONDITIONS

A. Before submitting a proposal, each bidder shall examine all plans and specifications relating to the work, shall visit the site of the project and become fully informed of the extent and character of the work required, including all required utilities.

B. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or the amount of work to be done, it being fully understood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein, or indicated on the accompanying plans or required by nature of the site of which may be fairly implied as essential to the execution and completion of any and all parts of the work.

1.11 SUBMITTALS

A. Refer to Section 26 00 90, Electrical Submittal Procedures.

1.12 QUALITY ASSURANCE

A. Provide complete installations of and verify that all systems, comply with NFPA 70, latest edition. The more stringent of the N.E.C. or specifications shall apply to this project.

B. All materials furnished under this Contract shall be new, free from defects of any kind, of the quality and design hereinafter specified, and shall conform to the standards of Underwriter's Laboratories Inc., except for equipment which U.L. does not list or provide label service.

C. Submit a bid on the basis of a complete installation including all labor, material, delivery, insurance, permits, inspection fees and tests required even though each and every item necessary is not specifically mentioned or shown.

D. In case of any conflict between the specifications, plans and ordinances, the ordinances shall govern. In case of any conflict between the specifications and plans, the Engineer shall make the final decision. Refer to Division 1 - General Requirements.

1.13 CONTRACTOR'S RESPONSIBILITY

A. Erect barricades, protective fencing, and signs as required to prevent injury to personnel on site.

B. Coordinate all utility services and/or revisions with utility companies for base bid.

C. Make permanent connection to new utilities or existing lines. Determine depth and location, and bid accordingly. Relocate and repair any existing lines cut by general construction work.

D. Plans do not show exact location and elevations of lines. Deviate from plans as required to conform to the general construction, provide proper grading and installation.

E. Maintain all utility services during construction to existing portions of job that remain.

F. Procure and pay for all necessary permits or licenses to carry out the work. Pay all costs in connection with metering.

G. Obtain and pay for all the necessary certificates of approval which must be delivered to the Architect before final acceptance of the work.

H. Periodically remove rubbish, clean or repair all surfaces marred by the work required under this contract.

I. Where job conditions require changes in indicated locations and arrangement, make such changes without extra cost to Owner.

J. Exposed piping and/or other materials will not be permitted in the finished job except where noted on the drawings.

K. Provide required hook-up to line voltage at all electromagnetic door holder/release, fire/smoke dampers, and smoke dampers. Provide required relays and wiring to fire alarm panels and coordinate with other specified work.

L. Accomplish all demolition and remodeling work involving this trade in a manner and completeness to provide the appearance of new construction work.

M. Replace any usable equipment and/or structure damaged during demolition and remodel work.

1.14 SUBSTITUTION OF PRODUCTS

A. Substitution of products specified herein will be considered only when a complete list of proposed alternative equipment is submitted to the Engineer in writing, supported by adequate technical and cost data. This includes a complete description of the proposed substitution, drawings, catalog cuts, performance data, test data, or any other data or information necessary for evaluation.

B. All proposed substitutions and data must be received by the Engineer no less than ten working days prior to the schedule date for opening of bids.

C. The Engineer will consider all such submittals and the Architect will issue an addendum listing items which the Engineer considers acceptable. Only such items as specified or approved as acceptable will be installed on this project.

D. Manufacturers' names are listed herein and on the plans to establish a standard of quality and design. Where a manufacturer's name is mentioned, products of other manufacturers will be acceptable, if in the opinion of the Engineer, the substitute material is of equivalent quality or better than that of the material specified.

E. The Contractor's Bid represents that the bid price is based solely upon the materials and equipment described in the Bid Documents (including addenda, if any) and that he contemplates no substitutions or extras.

F. Items noted as "No Substitutes" shall be as specified only.

G. Samples shall be provided by the manufacturer of the proposed substitute unit for evaluation when required at no charge and non-returnable.

H. Requests for substitution are understood to mean that the Contractor:
   1. Has personally investigated the proposed substitution and determined that it is equivalent or superior in all respects to that specified.
   2. Will provide the same guarantee for the substitution that he would for that specified.
   3. Will, at no cost to the Owner, replace the substitute item with the specified product if the substitute item fails to perform satisfactorily.

I. After Award of the Contract, substitutions will be considered only under one or more of the following circumstances.
   1. The substitution is required for compliance with subsequent interpretations of code or insurance requirements.
   2. The specified product is unavailable through no fault of the Contractor.
   3. The manufacturer refuses to warranty the specified products as required.
   4. Subsequent information that the specified product is unable to perform properly or to fit in the designated space.
   5. In the Engineer's sole judgment, the substitution would be in the Owner's best interest.

J. Revisions to the electrical system caused by substitutions shall be under the supervision of the Engineer at a standard hourly rate charged by the Engineer and shall be paid by the Contractor originating the changes.

1.15 PROJECT RECORD DOCUMENTS

A. This Contractor shall keep a set of plans on the job, noting daily all changes made in connection with the final installation including exact dimensioned locations of all new and existing switchgear, devices, fixtures, equipment and new or existing site utilities and lights.

B. Upon submitting his request for final payment, he shall turn over to the Architect, record document submittals as outlined in Division 1 - General Requirements of the Specifications.

C. In addition to the above, the Contractor shall accumulate during the job's progress the following data, in duplication. Two (2) each prepared in a three inch (3"), 3-ring binder, neat in appearance of sufficient size and turned over to the Architect for checking and subsequent delivery to the Owner:
   1. All warranties, guarantees and manufacturer's directions on equipment and material covered by the Contract.
   2. All shop drawings.
   3. Set of operating instructions. Operating instructions shall also include recommended maintenance and seasonal changeover procedures.
   4. Any and all other data and/or plans required during construction.
   5. Repair parts lists of all major items and equipment including name, address and telephone number of local supplier or agent.

D. The first page, or pages, shall have the names, addresses, and telephone numbers of the following:
   1. General Contractor and all sub-contractors.
   2. Major Equipment Suppliers.
   3. Submit megger reading log copies in accordance with Section 26 08 11.
   4. Submit ground tests methods and results in accordance with Section 26 08 11 & 26 05 26.
   5. Submit testing of electrical system results in accordance with Section 26 08 11.
   6. Submit conductor insulation test results in accordance with Section 26 05 19.
   7. Submit SPD warranty in accordance with Section 26 43 00.

1.16 PLANS AND SPECIFICATIONS

A. The intent of the drawings is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system.

B. Electrical drawings are generally diagrammatic and show approximate location and extent of work.

C. Install the work complete including minor details necessary to perform the function indicated. Provide an electrical system (including all hook ups) complete in every respect and ready to operate.

D. If clarification is needed, consult the Engineer.

E. Review pertinent drawings and adjust the work to conditions shown. Where discrepancies occur between drawings, specifications, and actual field conditions, immediately notify the Engineer for his interpretation.

F. The Architect reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.

G. Contractor, subcontractor, vendors and suppliers are required to waive subrogation against Owner and Engineer.

1.17 ELECTRICAL WIRING AND EQUIPMENT FOR MECHANICAL SYSTEMS

A. Electrical Contractor to Provide
   1. Line Voltage and hook-up to all plumbing equipment (Division 22), HVAC equipment (Division 23), and building automation equipment (Division 25), including required manual safety switches with fuses/heaters of required size.
   2. All conduit into accessible attic space for thermostats and sensors.
   3. All lighting contactors, mechanically held with control relay, required coil voltage coordinated with controls contractor.
   4. Junction Boxes (Standard One or Two Gang) required for controls contractor, and coordination with controls contractor.

B. Mechanical Contractor to Provide
   1. All motor starters (with heaters as required).
   2. All thermostats.
   3. All HVAC Equipment.
   4. All relays, contactors, and switches required to start/stop Mechanical Equipment other than switches shown on and required by Division 26.

C. Controls Contractor to Provide
   1. All required relays associated with Controls in specifications.
   2. All sensors.
   3. All conduit required above ceiling.
   4. All control wiring.

D. The Electrical plans are based on the equipment and devices scheduled shown on the drawings or as called for in the specifications. Should any mechanical equipment or device associated devices be changed or accepted from those which are shown or noted, all electrical and/or mechanical changes shall be made at the expense of the trade or contractor initiating the change with no expense to the Owner, Architect, Engineer or their representatives.

E. All conduit and boxes for thermostats and/or sensors shall be provided by this contractor. A thermostat or sensor junction box and 1/2" conduit to accessible attic and/or to corridor shall be provided for each room served with HVAC equipment. Coordinate with Division 23 for exact locations and requirements.

F. Details on Electrical drawings showing HVAC/Mechanical/Control Equipment providing of various relays devices, wiring and other equipment shall be provided by this Contractor as directed and as required per drawing.

1.18 UTILITIES, LOCATIONS, AND EXISTING CONDITIONS

A. Location of power company electrical service poles, transformers, telephone service pedestal, cable television service, and any existing underground services, where shown, have been obtained from substantially reliable sources, are shown as a general guide only, without guarantees as to accuracy.

B. The Contractor will examine the site, verify all requirements, service points, and availability of all services required to complete this project. No consideration will be granted for any alleged misunderstanding of the materials and labor to be provided as necessitated by nature of the site including those items which may be fairly implied as essential to the execution and completion of any and all parts of this project. All proposals shall take these existing conditions into consideration and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility. Verify location and check for existing underground utilities and lines before ditching.

C. The Contractor shall be responsible for repair of any cut or damaged lines or utilities he uncovers. There are lines and utilities not shown on any plans.

1.19 FINAL COMPLETION REQUIREMENTS

A. The following will be required at time of final completion.
   1. Refer to general conditions.
   2. Final clean up completed.
   3. All systems are fully operational, all material and devices installed and tested.
   4. Ground tests (megger readings) performed, two copies of method used, and results attached.
   5. Project Record Documents submitted to the Architect.
   6. Spare material delivered to the Owner and documented.
   7. Owner instructions completed.

1.20 MANUFACTURER'S INSTRUCTIONS

A. All equipment and devices shall be installed in accordance with the drawings and specifications, manufacturer's instructions and applicable codes.

B. Where specifications call for installation of a product to be in accordance with manufacturer's instructions and/or where manufacturer's instructions are required for installation of a product, it shall be the contractor's responsibility to obtain the necessary applicable manufacturer's instructions and install the product in accordance with the manufacturer's instructions. It shall be the Contractor's responsibility to install all equipment, materials, and devices shown on the plans and as called out in these specifications even if manufacturer's instructions are absolutely unattainable.

1.21 INSTALLATION

A. Cooperation with trades of adjacent, related or affected materials or operations, and or trades performing continuations of this work under subsequent contracts is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades, including under the general contractor Division 1, and Division 23.

B. The Electrical Contractor shall coordinate installation of the electrical system with the General Contractor, Mechanical, Plumbing, and Communications Contractors to insure a complete working system for the Owner.

C. Where required, all conduit and boxes for all systems, except mechanical controls specified otherwise, shall be provided by the Electrical Contractor. Any and all allowances shall be included.

D. All wiring shall be enclosed in conduit or raceway in all exposed areas such as gymnasium, shops, stages, or field houses.

E. Work must be performed by workmen skilled in their trade. The installation must be complete whether the work is concealed or exposed.

F. The Contractor shall construct foundations for floor mounted equipment where indicated on the Drawings. Foundations generally shall be built up from structural floor slabs and shall be made of 3000 psi concrete four (4) inches thick unless otherwise indicated or specified. Top edges shall be beveled. All exposed surfaces shall be finished with cement mortar troweled smooth. Reinforcing shall be 6 x 6-10/10 welded wire mesh.

G. Equipment shall be secured to foundations by this Contractor with anchor bolts embedded in the concrete of ample size and proper arrangements to suit equipment furnished.

H. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings. Branch circuits shall not be installed in or under the slab, and will not be accepted unless shown or required on the drawings.

I. Coordinate the actual locations of electrical outlets and equipment with building features and mechanical equipment as indicated on architectural, structural and mechanical drawings. Review with the Architect any proposed changes in outlet or equipment location. Relocation of outlets before installation, of up to 3 feet from the position indicated, may be directed without additional cost. Remove and relocate outlets placed in an unsuitable location when so requested by the Architect.

1.22 TEMPORARY SERVICE AND LIGHTING

A. Electrical service to all portions of existing buildings at the construction site not involved with the project shall remain in operation throughout construction. Provide all required temporary electrical service in the base bid to all required areas so as to satisfy OSHA requirements.

B. All metering and temporary electrical service charges and/or costs of utilities shall be paid by The Contractor/Managing Construction Contractor.

1.23 ADDITIONAL MATERIALS

A. Additional materials to be a dollar cost in the base bid. At the end of the project the contractor shall generate a dollar amount credited back to the owner for any unused items. All attic stock shall be provided to the owner at substantial completion. The base bid shall include all additional materials and attic stock.

B. Additional Materials -Include the following cost on a dollar basis in the base bid:
   1. All costs to provide 15 additional HVAC electrical circuits, all required circuit breakers, disconnect, fuses, wiring, conduit, labor and devices as specified and directed by Architect. Each circuit to be priced with a rating of 3P 60 amps, and at a distance of 100 feet to furthermost device.

PART 2 PRODUCTS

A. Not Used

PART 3 EXECUTION

3.1 INSTALLATION

A. All electrical connections shall be made per NEC 110.14. Additionally, where torque values are listed in manufacturer instructions, a calibrated torque tool shall be used to achieve indicated torque values.

END OF SECTION

SECTION 26 00 30

WARRANTY PERIOD

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Procedures during the warranty period.

1.2 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Division 26, Section 26 00 00, apply to this Section.
   1. Section 26 00 00 - Electrical

1.3 WARRANTY

A. This Contractor shall warranty all work against defective materials and workmanship for a period of one year from and after date of acceptance of the installation by the owner.

B. Neither the final payment nor any provisions in Contract Documents shall relieve this Contractor, or the Contractor, of the responsibility for faulty materials or workmanship.

C. The contractor shall remedy any defects due thereto, and pay for any damage to other work resulting there from, which shall appear.

D. This Warranty shall not be construed to include the normal maintenance of the various components of the system covered by these specifications.

1.4 MAINTENANCE SERVICE

A. Provide normal maintenance services recommended by the manufacturer at no additional cost to the Owner during the warranty period.

PART 2 PRODUCTS

A. Not Used.

PART 3 EXECUTION

A. Not Used.

END OF SECTION

SECTION 26 00 90

ELECTRICAL SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This section contains requirements applicable to Division 26 submittals.

1.2 SECTION INCLUDES

A. This section includes, but is not limited to:
   1. Electrical submittal procedures
   2. List of required Division 26 submittals to the engineer

B. This section applies only to the Division 26 specifications. Submittals required by other specification divisions are not included here, even though the same subcontractor may be providing work under other divisions.

1.3 SUBMITTALS

A. The materials, workmanship, design, and arrangement of all work installed under this contract shall be subject to the review of the architect, engineer and owner.

B. Manufacturers: Manufacturers submitted shall be as per the acceptable manufacturers listed in each specification section or referenced schedule. For additional manufacturers requiring approval, reference the Substitution of Products article in section 26 00 00.

C. Required submittals: Refer to the Submittals article of each individual Division 26 specification section for the required items to be submitted.

D. Color selection: Some products require that a color selection be coordinated with the architect. Information regarding such products shall be submitted to the architect.

E. Contractor’s coordination submittals: The contractor may require his subcontractors to provide drawings, setting diagrams, and similar information to help coordinate the project, but such data shall remain between the contractor and his subcontractors and will not be reviewed by the engineer.

F. Electronic Submittals: Provide submittals in pdf format. Paper submittals will be rejected.

G. Coordination correspondence: The contractor may desire to verify the acceptability of a particular item prior to assembling the submittal package. The contractor may send material directly to the engineer for comments and feedback. This communication, whether by mail, fax, or e-mail, will be treated as normal coordination correspondence and will not be tracked or documented as a formal submittal. The engineer may or may not respond to such correspondence. If the engineer agrees, in writing, to the use of a particular item, then that same material shall be included in the submittal package along with a copy of the correspondence.

H. Unapproved products: If materials or equipment are installed before being reviewed and approved by the engineer, the contractor shall be liable for the removal and replacement of such unapproved materials and equipment, at no additional expense to the owner. Additionally, if the removal and replacement of unapproved materials or equipment necessitates the removal and replacement of other related materials or equipment, then the contractor shall be liable for the removal and replacement of the related materials and equipment at no additional expense to the owner.

1.4 PRODUCT DATA

A. Where the content of manufacturer submittal literature includes data not pertinent to the submittal, clearly indicate which portions of the contents are being submitted for review. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested shall be specific and identifications in catalog, pamphlets, etc., of items submitted shall be clearly made in a contrasting color or highlighting. Data of a general nature shall not be acceptable.

1.5 SHOP DRAWINGS

A. Scale and measurements: Make shop drawings accurately to a scale sufficiently large to show all pertinent aspects of the item.

B. Types of prints required: Submit in pdf format.

1.6 SEQUENCING

A. Submit product information within 30 calendar days after the contractor has received the owner's notice to proceed.

B. After the engineer has reviewed the submittals, make necessary revisions as directed by the engineer and resubmit.

C. After the submittal has been reviewed and approved by the engineer, proceed to purchase materials and perform the work.

1.7 SCHEDULING

A. Failure to submit items that meet the requirements of the contract documents in ample time for review shall not entitle the contractor to an extension of contract time, and no claim for extension by reason of such default shall be allowed. The contractor may be held liable for delays so occasioned.

PART 2 PRODUCTS

A. Not applicable.

PART 3 EXECUTION

3.1 GENERAL

A. Submit product data, shop drawings, samples, quality assurance submittals, quality control submittals, and other items in accordance with the requirements of this section, applicable sections in Division 1, and additional requirements of each individual Division 26 specification section.

3.2 SUBMITTAL ORGANIZATION

A. Provide a submittal cover page that lists at least the following:
   1. Project name
   2. Date
   3. Name and address of architect
   4. Name and address of engineer
   5. Name, address and telephone number of electrical distributor

6. Name, address and telephone number of prime contractor
7. Name, address and telephone number of electrical contractor

B. Provide an index page listing all items submitted.

C. The contractor shall call to the attention of the engineer by letter, included in the submittal after the index page, any instance in which the submittals are known to differ from the requirements of the contract documents.

D. Organize all required items by specification section. All material for each specification section shall be in one single pdf file. Material for multiple specification sections may be combined into one file.

E. The material for each specification section shall be organized as follows:
1. The first page shall indicate the specification number and title and the name, address and telephone number of the vendor or vendor's representative, if applicable.
2. Refer to the individual Division 26 specification sections for any required organization of the submittal material within each submittal section.

F. Send pdf submittals to the engineer's office via email or other electronic means.

G. Submittals not organized as described here may be rejected, without being reviewed, as not complying with the provisions of the contract.

3.3 CLOSEOUT SUBMITTALS

A. Provide close-out submittals in accordance with the requirements of Division 1.

3.4 SCHEDULES

A. Division 26 Submittal Schedule: The Division 26 submittal shall include the following items for each Division 26 specification section that is in the contract documents. Coordinate this list with the submittal requirements listed in each specification section. If an item has been omitted from either list but is included in the other, then provide that item in the submittal. In case of conflicting or unclear requirements, contact the engineer.

Section	Submit on the following	1	2	3	4	Arch Sub #
26 05 19	**Low-Voltage Electrical Power Conductors and Cables**					
	Line voltage conductors					
26 05 26	**Grounding and Bonding for Electrical Systems**					
	Grounding materials and devices					
26 05 33.11	**Raceways and Conduits for Electrical Systems**					
	Raceways and conduit					
	Fittings					
	Wireways					
	Supports for rooftop conduits					
	Labeling					
26 05 33.13	**Boxes and Fittings for Electrical Systems**					
	Fittings					
	Cover plates					
	Junction boxes					
	Outlet boxes					
	Pull boxes					
	Floor boxes					
	Extension rings					
26 05 53	**Identification for Electrical Systems**					
	Label material					
	Sample identification tag					
26 24 16	**Panelboards**					
	Switchgear					
	Electrical rooms (Drawn to scale & dimensioned)					
26 27 26	**Wiring Devices**					
	Devices					
	Device plates					
	Keys					
26 28 13	**Fuses**					
	Fuses					
26 28 16	**Enclosed Switches and Circuit Breakers**					
	Safety switches					
26 43 00	**Surge Protective Devices (SPD)**					
	Service entrance SPD					
	Sub-panel SPD					
	HVAC SPD					

1 - Reviewed
2 - Furnish as corrected in comments, resubmit not required
3 - Revise and Resubmit based on comments
4 - Rejected based on comments

END OF SECTION

SECTION 26 05 11

ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical demolition.

B. Off-site removal of materials not reused.

1.2 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 05 53 - Identification for Electrical Systems

PART 2 PRODUCTS

A. Not used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing field measurements, circuiting arrangements, wiring and equipment served in areas as shown on the Drawings. Adjust all circuiting, wiring and materials to be provided as required by job conditions.

B. Verify abandoned wiring and equipment serving only abandoned facilities.

C. Drawings are based on casual field observation and existing record documents. Report discrepancies to the Engineer before disturbing existing installation.

D. The Contractor accepts the existing conditions when beginning demolition.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors and ceilings as shown or required.

B. Coordinate utility service outage with the respective utility company and the Owner.

C. Provide temporary wiring and connections to maintain required existing systems in service during construction.

D. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Verify phasing on existing equipment and coordinate new phasing before energizing revised service.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provision of Division 1 and this section.

B. Remove, relocate and extend existing installations to accommodate new construction as required.

C. Remove abandoned wiring to the source of the supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls, floors and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed in masonry construction.

F. Disconnect and remove electrical devices and equipment serving equipment that has been removed.

G. Disconnect and remove abandoned lighting fixtures. Remove brackets, stems, hangers and other accessories.

H. Repair adjacent construction and finishes damaged during demolition and extension work.

I. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

J. Extend existing installations using materials and methods compatible with existing electrical installations or as specified.

K. Confirm with Owner or Architect regarding the handling and disposal/reuse of removed material, equipment, devices, lights, etc.

3.4 REPAIR/RESTORATION

A. Clean and repair existing materials and equipment, in areas of revision, which remain or which are to be reused.

B. Panelboards:
   1. Clean exposed surfaces and check tightness of electrical connections.
   2. Replace damaged circuit breakers and provide closure plates for vacant positions.
   3. Provide typed circuit directory showing revised circuiting arrangement as specified, on all existing switchgear.
   4. Provide new identification nameplates per Section 26 05 53.

3.5 RE-INSTALLATION

A. Install all relocated materials and equipment under the provisions of Divisions 1 and 26.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section includes conductors for power circuits, including terminations and connectors.

1.2 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 00 90 - Electrical Submittal Procedures

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems

D. Section 26 08 11 - Testing of Electrical System

1.3 REFERENCES

A. ANSI/UL 83 - Thermoplastic-Insulated Wires

B. ICEA S-61-402 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

C. UL 44 - Rubber Insulated Wires and Cables

D. National Electric Code

E. UL 493 - Thermoplastic Insulated Underground Feeder and Branch Circuit Cables

1.4 SUBMITTALS

A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 - Electrical Submittal Procedures.

B. Product Data: Submit product data for the following:
   1. Conductors for power circuits
   2. Conductor terminations
   3. Connectors

C. Closeout Submittals: Closeout submittals shall include the following.
   1. Submit letter certifying acceptable testing of all branch circuits.
   2. Submit insulation test results for all new feeders installed in this project.

1.5 QUALITY ASSURANCE

A. General work practices for electrical construction shall be in accordance with NECA 1, Standard Practices for Good Workmanship in Electrical Construction.

B. Regulatory Requirements: All products provided under this section shall be UL listed for the intended use.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Material shall be stored in a clean and dry location until installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Conductors shall be manufactured in the United States. Acceptable manufacturers are:
   1. Encore Wire
   2. Southwire
   3. Cerro Wire
   4. Alan Wire
   5. General Cable

B. All other manufacturers shall require pre-approval in accordance with specification section 26 00 00.

2.2 MATERIALS

A. All feeders to be soft-drawn annealed copper.

B. All branch circuit conductors shall be soft-drawn annealed copper.

2.3 MANUFACTURED UNITS

A. Manufactured conductors for power circuits:
   1. All conductors for power circuits shall be rated for at least 600 volts.
   2. The insulation for power conductors shall be type THWN-2 or THHN/THWN.
   3. Conductors for power circuits shall be #12 AWG or larger.
   4. Conductors for power circuits that are #12 AWG or #10 AWG shall be solid. Conductors for power circuits that are #8 AWG and larger shall be stranded.
   5. Conductors sized #6 AWG and smaller shall have factory colored insulation.

B. MC Cable: MC cable is not approved for use on this project.

C. Manufactured conductor terminations and connectors:
   1. All accessory materials such as connectors, splice and tap fittings, and terminations shall be of a type designed or intended and suitable for the use. They shall be compatible with the conductor material.
   2. Conductors shall be connected and terminated using suitable listed clamps, listed pressure connectors, listed compression terminals or listed lugs and hardware of the proper size for the application.
   3. Only connection devices that require the complete removal of the conductor jacket or insulation and result in a connection to the complete conductor surface area are suitable for use. Insulation piercing type connectors shall not be used.
   4. Splices and taps shall have a mechanical strength and insulation rating at least as that of the conductors.
   5. Compression systems shall include crimped die index and company logo for purposes of inspection. Aluminum shall not be used for connection purposes.

PART 3 EXECUTION

3.1 SITE VERIFICATION OF CONDITIONS

A. Do not install the conductors until raceway system is complete.

B. Before installing the conductors for any power circuit or feeder, verify that the conductor ampacity is at least as large as the rating of the overcurrent device protecting it. In the event that the conductors would not be adequately protected, notify the engineer before installation.

3.2 INSTALLATION

A. Wire Sizing: Provide conductors sized as indicated on drawings unless modified as described below. Where conductor sizes have been omitted from drawings, base bid shall include conductors with ampacity as least as large as the overcurrent protection device protecting the conductors, or at least as large as the amp rating of the load being served, whichever is greater. In such cases, notify the engineer before installation for size verification. When pulling 120v branch circuits, #12 wire shall not be run more than 90', #10 wire shall not be run more than 120', #8 wire shall not be run more than 150', etc.

B. Neutral Conductors: Provide a separate neutral conductor for each circuit. Multiple circuits shall not share a common neutral. Neutral conductors shall be sized as large as the phase conductors. Neutral conductors shall not be of a reduced size.

C. Equipment grounding conductors: Provide equipment grounding conductors in accordance with specification section 26 05 26 - Grounding and Bonding for Electrical Systems.

D. Number of Conductors per Conduit: When #12 AWG conductors are used on 20-amp circuits, install no more than six conductors in a single conduit run. When #10 AWG conductors are used on 20-amp circuits, install no more than nine conductors in a single conduit run. Otherwise, there shall be no more than three conductors in each conduit run. The equipment grounding conductor shall not be counted for the preceding statements.

E. Installation in Raceways:
   1. Install all conductors for power circuits in raceways.
   2. All conductors to be installed in a raceway shall be pulled together. Use an approved wire pulling compound when pulling large conductors.
   3. Do not bend any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of conductors.
   4. Do not exceed manufacturer's recommended values for maximum pulling tension.
   5. When installing conductors in existing conduit, the interior of the existing conduit shall be cleaned prior to the installation of the new conductors to insure that there is nothing that will damage the insulation.
   6. The pulling device shall be of a type that will not damage the raceway.

F. Terminations:
   1. Use pressure type lugs or connectors for terminations or splices of all stranded conductors. Use ring tongue type terminators on all control wiring. More than one conductor shall not be installed in any termination unless the termination is marked as suitable for more than one conductor. With the written approval of the engineer's office, an exception to this may be allowed for the installation of the surge protective devices required in specification section 26 43 00 Surge Protective Devices.
   2. Conductors shall not be supported solely by their terminations.
   3. Terminations shall be made such that the stripped length of the conductor is no longer than required for the terminal, lug, or connector.

4. Conductive antioxidant shall be applied on all outdoor connections and connections in damp or wet locations.

G. Splices:
1. Conductor splices shall be kept to a minimum.
2. Where splices are necessary, they shall be in a box or enclosure. Splices within a conduit run are not acceptable.

H. Color Coding:
1. Provide factory colored insulated conductors for #6 AWG and smaller.
2. Color code larger insulated conductors with an approved field-applied tape 2" wide on each end of conductors.
3. If existing wiring in renovation or addition work has a consistent color coding, then match the existing and note in record documents. Otherwise, colors shall be as follows:

Line	**208/120V**	**240/120V**	**480/277V**
A	Black	Black	Brown
B	Red	Orange	Orange
C	Blue	Blue	Yellow
Neutral	White	White	Gray
Ground	Green	Green	Green
Isolated Ground	Green +Yellow	Green + Yellow	Green + Yellow

4. Switch leg shall be the same color as the un-switched phase wiring. Travelers, and special systems as selected by the Contractor. Note in record drawings.

I. Identification: All conductors in a panelboard shall be identified by means of tags or tape.

3.3 SITE TESTS

A. Perform in accordance with manufacturer's printed testing procedures, applicable industry standards, ANSI standards, IEEE standards, and NEMA standards. Provide testing equipment in good working order and which complies with the applicable industry standards and manufacturer's requirements. Submit a list of testing equipment used and date of last calibration.

B. Insulation Test: The insulation of each feeder run and each branch circuit shall be tested. The test shall be performed after the conductors have been pulled into the conduit and after terminations have been added, but before final connections are made.

C. Test the following:
1. Phase to phase resistance
2. Phase to neutral resistance
3. Phase to ground resistance
4. Neutral to ground resistance

D. Branch Circuits: The insulation of branch circuits may be tested with a standard ohm meter. Readings must indicate an open circuit to be acceptable. Submit letter documenting that all circuits have been tested and are acceptable.

E. Feeders:
1. Perform megger tests on all new feeder runs.
2. Tests shall be performed in accordance with the Publication "Instruction Manual For Megger Insulation Testers" by the Biddle Company.
3. Written documentation of the test results shall be submitted in accordance with specification section 26 08 11 - Testing of Electrical System.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.3 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 08 11 - Testing of Electrical System

1.4 REFERENCES

A. National Electrical Code

B. ANSI/IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

C. ANSI/UL 467 - Safety Standard for Grounding and Bonding Equipment.

1.5 SUBMITTALS

A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements.

B. Submit grounding materials and devices to be used.

C. Submit test results of megger reading to Engineer after installation of grounds with records for Owner.

D. Revisions to grounding will be to satisfaction of the Engineer at no cost by the Contractor.

PART 2 PRODUCTS

2.1 GROUND RODS

A. Copper cladding permanently bonded to a high-strength steel core, molten welded to core.

B. 3/4 inch by 10 feet (19mm by 30m) Straight, Conform to UL 467.

2.2 CONNECTIONS

2.2.1 GENERAL CONNECTION REQUIREMENTS

A. Listed and labeled as grounding connectors for the materials used.

2.2.2 OUTDOOR & BELOW GRADE GROUNDING CONNECTIONS

A. Welded.

B. Provide starting material in kit form.

C. Aluminum, copper and iron oxide.

D. No phosphorous or any other caustic, toxic or explosive substance may be used.

E. Manufacturer/Model
   1. Erico Products "Cadweld Exothermic"
   2. Thermoweld

2.2.3 OUTDOOR & ABOVE GRADE GROUNDING CONNECTIONS

A. Bonds and clamps.

B. Non-ferrous material which will not cause electrolytic action between the conductor and connector.

C. Provide exothermal welding where clamping is not accessible.

2.2.4 INDOOR GROUNDING & POWER CONNECTIONS

A. Provide clamps as listed for outdoor applications.

B. Use low smoke/low emission welding where not accessible.

C. Manufacturer/Model: Erico Products "Cadweld Exolon".

D. Service Entrance Grounding Connections: U-bolt with pressure plate.

2.3 WIRING

A. Copper 600 volt insulated conductors with a green-colored insulation for bonding.

B. Grounding conductors to be in accordance with NEC Table 250-95.

C. Bonding jumpers to be minimum cross-sectional area greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250-95.

D. Use to ground electrode and equipment grounding conductors.

2.4 MISCELLANEOUS CONDUCTORS

A. Ground Bus: Bare annealed copper bars of rectangular cross section. 98% IAGS conductivity, not less than 25% of feeders cross section area.

B. Braided Bonding Jumpers: Copper tape, braided No. 3/0 AWG bare copper wire, terminated with copper ferrules.

C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch (1mm) thick and 2 inches (50mm) wide, except as indicated.

PART 3 EXECUTION

3.1 APPLICATION

3.1.1 EQUIPMENT GROUNDING CONDUCTOR APPLICATION

A. Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.

B. All power circuits shall be provided with a separate copper insulated equipment grounding conductor (EGC) run in the raceway with the power conductors. The conduit is not to be used as the sole means of grounding. The insulation of the EGC shall be green.

C. Bonding to the EGC shall be provided at each end of metallic conduit runs and at all boxes and enclosures.

D. All branch circuits and feeders that require an isolated ground (IG) equipment grounding conductor shall be provided with a separate copper insulated IG equipment grounding conductor run in the raceway with the power conductors. The IG equipment grounding conductor shall be provided in addition to the normal EGC. The insulation of the IG equipment grounding conductor shall be green with a yellow stripe.

E. Conduits and boxes of IG circuits shall be bonded to the normal EGC as stated above. At outlet locations, the IG equipment grounding conductor shall connect only to the isolated ground terminal of an isolated ground outlet. There shall be no connection, either directly or indirectly, between the normal EGC and the IG equipment grounding conductor at any point other than at the source of a separately derived system (transformer) or at the service entrance.

F. The following circuits shall be provided with an IG equipment grounding conductor:
   1. Feeders providing power to panels equipped with an IG buss.
   2. All branch circuits originating at a panel with an IG buss.

3.1.2 COMMUNICATIONS

A. For communication systems, provide a #2 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each terminal cabinet or central equipment location and to the ground bar in all IDF / MDF rooms.

3.1.3 METAL POLES SUPPORTING OUTDOOR LIGHTING FIXTURES

A. Ground pole to a grounding electrode as indicated in addition to separate equipment grounding conductor run with supply branch circuit.

3.2 INSTALLATION

3.2.1 GENERAL

A. Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.

3.2.2 GROUND RODS

A. Locate a minimum of one-rod length from each other and at least the same distance from any other grounding electrode. Interconnect ground rods with bare conductors buried at least 24 inches (600 mm) below grade. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without damaging the copper coating or exposing the steel. Use 3/4 inch by 10-ft. (19mm by 30 m) ground rods except as otherwise indicated. Drive rods until tops are 6 inches (150mm) below finished floor or final grade except as otherwise indicated. Provide "Powerfill" "Gem" or equal conducting material in quantity recommended by manufacturer at all ground rods.

3.2.3 METALLIC WATER SERVICE PIPE

A. Provide insulated copper ground conductors, sized as indicated, in conduit from the building main service equipment, or the ground bus, to main metallic water service entrances to the building. Connect ground conductors to the main metallic water service pipes by means of ground clamps. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fittings. Do not install a grounding jumper around dielectric fittings. Bond the ground conductor conduit to the conductor at each end.

B. Route bond interior metal piping systems and metal air ducts to equipment ground conductors of pumps, fans, electric heaters, and air cleaners serving individual systems.

3.2.4 GROUND

A. Fabricate with 20 feet (60m) of conductor laid lengthwise in excavation for foundation or footings. Install so conductor is within 2 inches (50mm) of the bottom of the concrete. Where base of foundation is less than 20 feet (60m) in length, coil excess conductor at base of foundation. Bond conductor to reinforcing steel at four locations, minimum. Extend conductor below grade and connect to building grounding electrode.

3.3 CONNECTIONS

3.3.1 GENERAL

A. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

B. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series. Make connections with clean bare metal at points of contact.

C. Aluminum to steel connections shall be with stainless steel separators and mechanical clamps. Aluminum to galvanized steel connections will be with tin-plated copper jumpers and mechanical clamps.

D. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

3.3.2 EXOTHERMIC WELDED CONNECTIONS

A. Use for connections to structural steel and for underground connections except those at test wells. Install at connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

B. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushing and bare grounding conductors.

C. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening valves specified in UL 486A and UL 486B.

3.3.3 COMPRESSION-TYPE CONNECTIONS

A. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

3.3.4 MOISTURE PROTECTION

A. Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.

3.4 TESTS

A. Subject the completed grounding system to megger test at each location where a maximum ground resistance level is specified, at service disconnect enclosure ground terminal, and at ground test wells. Measure ground resistance without the soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method in accordance with Section 9.03 of IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System". Submit test results in accordance with Section 26 08 11 - Testing of Electrical System.

B. Ground/resistance maximum values shall be as follows:
   1. Equipment rated 500 kVA and less: 10 Ohms
   2. Equipment rated 500 kVA to 1000 kVA: 5 Ohms
   3. Equipment Grounds: 25 Ohms

3.5 CLEANING AND ADJUSTING

A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying and other work to their original condition. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Perform such work in accordance with Division 2 Section. Maintain disturbed surfaces, restore vegetation and restore disturbed paving as indicated.

END OF SECTION

SECTION 26 05 33.11

RACEWAYS AND CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Electrical raceway and conduit systems.

1.3 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems

1.4 REFERENCES

A. ANSI/ANSI C80.1 - Zinc-Coated Rigid Steel Conduit

B. ANSI/ANSI C80.4 - Zinc Coated Electrical Metallic Tubing

C. ANSI/ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing

D. ANSI/UL 1 - Flexible Metal Conduit

E. ANSI/UL 5 - Surface Metal Raceways and Fittings

F. ANSI/UL 651 - Rigid Nonmetallic Conduit

G. ANSI/UL 797 - Electrical Metallic Tubing

H. ANSI/UL 870 - Safety Standard for Wireways, Auxiliary Gutters and Associated Fittings

I. ETL PVC-001 - PVC-Coated Rigid Steel Conduit

J. NEMA TC2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80) and Fittings

K. NEMA TC3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

L. UL 6 - Rigid Metal Electrical Conduit

M. UL 360 - Liquid tight Flexible Steel Conduit

N. UL 467 - Electrical Grounding and Bonding Equipment

1.5 SUBMITTALS

A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements. Included in this section are all raceways and conduit, fittings, wireways, supports for conduit on roof, and labeling used. Provide samples upon specific request. U.L. labels affixed to each item of material.

1.6 DESCRIPTION OF WORK

A. The use of the various raceway systems is restricted to the types and other restrictions of the NEC and the local codes. Use of all such systems shall be verified with the local code authority before use. In the case of questionable or denied use, the contractor shall be required to use a raceway system permitted by the local code at no additional cost.

B. Where conduits pass through beams, outside walls, fire rated walls, or structural members, galvanized steel pipe sleeves shall be provided. The size of these sleeves shall be such as to permit readily the subsequent insertion of conduit of the proper size with adequate clearance for movement due to expansion and contraction. Where conduits pass through outside walls, the inside diameter of the galvanized iron pipe sleeves shall be at least 1/2" greater than the outside diameter of the service pipe. After the conduits are installed, fill the annular space between the conduit and its sleeve with a mastic or caulk. Use packing as required to accomplish this. At fire rated wall penetrations, use fire barrier.

C. Grounding: The installation shall comply with all NEC grounding requirements. See specification section 26 05 26 Grounding and Bonding for Electrical Systems for additional grounding requirements.

D. Exposed surface raceways are specifically not permitted, in new construction. Where a raceway is required, in existing construction, it shall be solid, without knockouts, with hinged cover, placed so that cover is gravity closed.

E. Install complete, separate conduit systems for all electrical systems on this project to include, but not limited to include the following.
   1. Electrical power and lighting feeders
   2. Electrical power and lighting circuits
   3. Control wiring furnished by this contractor
   4. Other electrical systems

F. Branch circuits shall not be installed in or under the ground floor slab and will not be accepted. The only exceptions being circuits and locations specifically required on the drawings to be in or under the floor slab.

G. Aluminum conduit shall not be installed in direct contact with concrete or masonry construction.

PART 2 PRODUCTS

2.1 CONDUITS AND FITTINGS

2.1.1 MINIMUM SIZES

A. Do not use conduit sized less than 1/2 inch steel, 3/4 inch for PVC conduit, 3/8 inch flexible metal conduit, for lengths not to exceed 72 inches supplying light fixtures.

2.1.2 RIGID METAL CONDUIT. (RSC) (RAC) (IMC)

A. Hot-dipped galvanized rigid steel (RSC), Intermediate Metallic (IMC) with zinc-coated threads and an outer coating of zinc chromate, Rigid Aluminum (RAC) accepted.

B. Fittings:
   1. Malleable iron, either cadmium plated or hot-dipped galvanized. Die cast zinc. Aluminum for aluminum conduit. To be insulated throat at terminations.
   2. Use of set screw or bolt-on connectors and couplings is not accepted.
   3. Use deflection and expansion couplings with bonding jumpers at all expansion joints where required. Steel Clamps.

C. Usage: Where exposed on interior and exterior of buildings including roof. All elbows of PVC conduit. Within or penetrating concrete slabs (RSC only).

2.1.3 PVC COATED RIGID METAL CONDUIT

A. NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6 and ETL PVC-001. The PVC coated galvanized rigid conduit must be ETL Verified to the Intertek ETL SEMKO High Temperature H2O PVC Coating Adhesion Test Procedure for 200 hours.

B. Fittings
   1. Malleable iron. Steel.
   2. Use fittings listed and labeled as complying with UL514B.
   3. Exterior Coating: Polyvinyl Chloride (PVC), minimum thickness of 40 mils.
   4. Interior Coating: Urethane, minimum thickness of 2 mils.

C. Usage: Damp or wet locations. The stub-up from below grade to above grade

2.1.4 ELECTRICAL METALLIC TUBING (EMT)

A. Galvanized Electrical Steel, Galvanized Thin Wall, or Aluminum Tubing

B. Fittings: Set screw or compression type. Indenter type is not accepted. Die cast zinc. Pressure cast. Malleable iron. Steel. Steel Clamps. To be insulated throat at terminations.

C. Usage: Concealed in interior walls and ceiling spaces. Exposed only in interior mechanical, electrical rooms, and equipment rooms. Gyms, activity spaces, stages as directed, above 10'-0" A.F.F. where exposed. Installation in or under the floor slab will not be accepted.

2.1.5 RIGID NONMETALLIC CONDUIT (RNC)

A. Schedule 40 heavy wall polyvinylchloride, high impact resistant.

B. Fittings: Solvent weld socket type

C. Usage: Underground, under slabs, all bends to be rigid steel. Do not penetrate slab with PVC. Do not use above slabs, above grade, or exposed. Use long sweep rigid steel 90's and rigid steel from 90's to and above grade.

2.1.6 FLEXIBLE METAL CONDUIT (FMC)

A. Spiral-wound, square-locked aluminum. Spiral-wound, square locked, hot-dipped galvanized steel.

B. Fittings: Cadmium plated two-screw, double-clamp malleable iron. Hot-dipped galvanized two-screw, double-clamp malleable iron. Malleable. Pressure cast. Steel cast. Steel/Malleable for 90°. Zinc coated, aluminum. To be insulated throat at terminations.

C. Usage:
1. May be used for light fixture whips.
2. May be used for final equipment connections, such as transformers, motors and HVAC equipment.
3. Total length not to exceed 72” above ceiling, 48” exposed below ceiling.
4. Exposed only in interior mechanical or electrical rooms.
5. For renovation work, may be used in existing walls only under the following conditions:
   a. The use of EMT or rigid conduit is not feasible.
   b. Written permission has been obtained from the engineer.
   c. Surface mounted conduit is not desired.
6. Installation in or under the floor slab will not be accepted.

2.1.7 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFC)

A. Spiral-wound, square-locked, hot-dipped galvanized steel strip plus a bonded outer jacket of PVC.

B. Fittings:
1. Cadmium plated, compression type, malleable iron. Hot-dipped galvanized, compression type, malleable iron. To be insulated throat at terminations.
2. Aluminum - Copper free (1% or less)

C. Usage:
1. Exterior equipment - 5' 0" Maximum length
2. Kitchen equipment - 4' 0" Maximum length

2.1.8 ACCEPTABLE MANUFACTURERS

A. Metallic Conduits: American Conduit, Pittsburgh, Alflex, AFC, Wheatland, Allied, Omega, Spang, and Nepco.

B. Nonmetallic Conduits: Carlon, Sedco, and Cantex.

C. PVC Coated Metallic Conduits: Plasti-Bond, Perma-Cote, and KorKap.

D. Fittings: Madison, Hubbell, Raco, Regal, Appleton, Thomas & Betts, Eaton, Steel City, and ECN Korns.

E. Others: As listed with products.

2.2 WIREWAYS

A. Not less than 16 gauge sheet steel. Cross section dimensions not less than 4 inches by 4 inches, or as noted. ANSI gray epoxy paint over rust-inhibiting prime coat. NEMA rated. Large enclosed surface metal raceway used where conduit is not accessible, or use of conduit is not feasible.

B. Manufacturers: Square D., Hoffman

2.3 METALLIC SURFACE RACEWAYS

A. Not less than 0.04" thickness sheet steel with enamel over rust-inhibiting prime coat, ivory finish, not less than 0.25 square inch cross section.

B. One piece for up to 7 - #12 AWG wire capacity.

C. Two piece for up to 8 - #12 AWG wire or more capacity.

D. Usage: Exposed on existing classroom and public walls where concealment of EMT or FMC is prohibitive, and/or in lieu of rigid metal conduit. Use deep boxes for mounting fire alarm devices.

E. Manufacturers: Wiremold, Tehalit, Mono-Systems, Panduit

2.4 NON-METALLIC SURFACE RACEWAYS

A. Rigid polyvinyl chloride (PVC), ivory finish, not less than .20 square inch cross section. Two piece construction, minimum 5 - #12 AWG wire capacity.

B. Usage: Exposed on existing walls, as noted on drawings, where concealment of EMT or FMC and/or in lieu of rigid metal conduit is prohibitive. Use deep boxes for mounting fire alarm devices.

C. Manufacturers: Tehalit, Wiremold, Hubbell, Mono-Systems, Panduit

2.5 POWER/DATA RACEWAYS

A. Wiremold AL4320 series, two compartment, with isolated ground duplex receptacles and data devices as noted on drawings. Provide all required mounting accessories. Serve raceways from flush outlet boxes mounted behind raceway as required and as directed.

2.6 ROOFTOP CONDUIT SUPPORTS

A. All roof-mounted conduits are to be supported and secured using an approved pipestand product manufactured for the purpose of supporting piping and conduit.

B. Adjustable height.

C. Metal parts to be stainless steel or galvanized steel.

D. Pipestand top to be mounted onto a 12” x 24” x 2” concrete block.

E. Concrete block to be placed over a ½” traffic block which is securely attached with mastic to the roof.

F. Electrical conduit, gas piping, and condensate may be mounted onto the same support.

2.7 APPROVED PRODUCTS

A. Pipe support:
   1. Miro Industries Model 24-R-AH, 48-R-AH
   2. Portable pipe hangers #PP10

B. Multiple-pipe support :
   1. Miro Industries Models 24AH and 48 AH

PART 3 EXECUTION

3.1 PREPARATION

A. Place sleeves in the cavities of walls and floor slabs for the free passage of conduits.

B. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work.

C. Apply caulking for sleeves through floors and through exterior walls.

D. Be sure that plugs or caps are installed before concrete placement begins.

3.2 INSTALLATION

3.2.1 CONDUITS

A. Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. At conduit terminations, provide insulated throat fittings. Where conduits terminate in equipment having a ground bus, such as in switchgear, and panelboards, provide conduit with an insulated grounding bushing.

B. It is intended to reuse the existing conduits in existing construction, if they prove to be adequate in size and integrity.

C. Install conduit and tubing products as indicated, in accordance with applicable requirements of NEC and the NECA "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended function.

D. Cap open ends of raceways until conductors are installed.

E. Wherever possible and unless otherwise indicated on the drawings, install conduit concealed in walls, partitions and above the ceiling. Install conduit exposed in ceiling area at the structure in electrical rooms, mechanical rooms and other rooms where ceilings are not present or scheduled.

F. In mechanical rooms install conduit to equipment not adjacent to walls, by dropping conduits exposed from overhead.

G. Install conduits parallel and supported on Unistrut or equal trapezes and anchored with split ring hangers, conduit straps or other devices specifically designed for the purpose. Wire ties are not permitted. Do not support conduit from ceiling system supports.

H. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer's Installation Manual. All clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide should be followed To assure correct installation, the installer shall be certified by Manufacturer to install coated conduit.

I. Rigid metal conduit installed on the roof shall be securely fastened in place and supported on approved supports at least every 10 feet. Additionally, conduit shall be securely fastened and supported within 3 feet of each outlet box, junction box, device box, cabinet, conduit body, or other conduit termination.

J. Liquid-tight flexible metal conduit on the roof shall be securely fastened in place by an approved means within 12 inches of each box, cabinet, conduit body, or other conduit

termination, and shall be supported and secured at intervals not to exceed 4.5 feet. Flexible conduit cannot lay on roof.

K. Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection. Run green ground wire in all PVC conduit and extend to ground bus.

L. Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Branch circuits installed in or under slabs on grade will not be accepted unless noted on drawings. Branch circuits shall be installed below floor slabs above first floor.

M. Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors. See Section 26 05 19 Conductors for additional requirements for installation of conductors in raceways.

N. Conduit and raceways shall be suspended from building structure, not from ceiling suspension system.

O. Make bends with standard ells or conduit bent in accordance with the NEC. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of four 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.

P. Securely fasten and support all conduit runs. Provide required clamps, straps, clips, hangers and brackets. Raceways run in joists shall be secured to joists with clamps at 20'0" maximum spacing. Raceways run parallel to joists shall be supported by caddy clips (1 inch or smaller) or in unistrut/threaded rods/beam clamps trapeze at 15'-0" centers. Raceways run perpendicular to bottom of joists shall be secured with individual conduit hangers at 10'-0" maximum spacing or unistrut/threaded rods/beam clamps at 15'-0" maximum centers. Raceways supported by straps at walls shall be supported per NEC. Support all raceways within one foot of each box, cabinet, disconnect, bend or other raceway termination.

Q. Run flexible conduit to all recessed fluorescent fixtures in accessible ceilings. Do not use more than 4 flexible metal conduits per junction box to supply light fixtures in a location. Do not supply a fixture from another with any Raceway or FMC. Suspend junction boxes and conduits from high roofs with hangers and trapeze.

R. Provide two spare 1 inch conduits stubbed into attic space at flush mounted electrical cabinets.

S. Provide a Greenlee #431 or equal (240 lbs.) nylon pulling line in conduits in which wiring is not installed under this work, such as telephone, signal, and similar systems. Identify both ends of the line by means of labels or tags reading "Pulling Line".

T. Use expansion-deflection fittings on conduits 2 inches and larger crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.

U. Openings around electrical penetrations of fire resistance rated walls, partitions, floors or ceilings shall be made using approved methods so as to maintain the original fire resistance rating. See NEC 300-21.

3.2.2 WIREWAYS

A. Install wireways, where noted or required. Field apply a 90 percent grey zinc paint coating over cuts or scratches before any other finish is applied.

3.2.3 SURFACE RACEWAYS

A. Install surface raceways, where noted or required. At metallic raceways, field apply a 90 percent zinc paint coating to cuts or scratches before any other finish is applied.

3.2.4 COMMUNICATION SYSTEMS

A. This contractor shall provide all raceways and conduits for all communication systems shown and/or required on the drawings. Communication Systems may include but are not limited to fire alarms, intercoms, telephones, television, security, computer data, antenna and media management.

B. This contractor shall provide a conduit pathway above ceiling for fire alarm, data, av systems, etc. between all spaces and the corridor, where walls go to deck. Coordinate exact conduit size (1" to 2") and quantity with low voltage contractors and installers.

C. Raceways and conduit requirements shall be coordinated by this contractor with each Communication Systems Contractor and the general contractor.

D. See Specification Divisions 27 and 28 for additional requirements.

3.3 COLOR CODING

A. Provide color bands approximately two inches wide, applied at 10 foot centers and at pull box locations.

B. Color Codes:

1.	Fire Alarm System	Red
2.	Voice/Data	Blue
3.	Security System	Green
4.	Media Management	Yellow
5.	CATV/MATV	Black

END OF SECTION

SECTION 26 05 33.13

BOXES AND FITTINGS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Outlet boxes

B. Junction boxes

C. Pull and splice boxes

1.3 RELATED SECTION

A. Section 26 00 00 - Electrical

1.4 REFERENCES

A. ANSI/NEMA Publication No. OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports, and Cast Aluminum Covers.

B. ANSI/UL 514 - Electrical Outlet Boxes and Fittings.

C. NEC 370-23(d)

1.5 DESCRIPTION OF WORK

A. The extent of electrical box and electrical fitting work is indicated by drawings and the requirements of this section.

B. The types of electrical boxes and fittings required for the project include the following:
   1. Outlet boxes
   2. Junction boxes
   3. Pull boxes
   4. Conduit bodies

1.6 SUBMITTALS

A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements.

B. Include cut sheets of fittings, cover plates, junction boxes, outlet boxes, pull boxes, floor boxes and extension rings. Provide samples upon specific request.

PART 2 PRODUCTS

2.1 OUTLET BOXES

A. Flush Device Boxes
   1. Galvanized steel boxes, with extension rings as required. Use 1½ inch deep by 4 inches long, square or rectangular, unless otherwise noted on drawings.
   2. Provide galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.
   3. In boxes with multiple switches, where the voltage between adjacent switches exceeds 300 volts, provide an enclosure equipped with identified, securely installed barriers between adjacent devices.

B. Exterior or Exposed Device Boxes: Use FS or FD cast boxes with threaded hubs.

C. Interior Lighting Fixture Boxes: Galvanized steel with fixture stud supports and attachments to properly support ceiling and bracket-type lighting fixtures. Provide galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides and with threaded holes with screws for securing box covers or wiring devices. 1½ inch deep by 4 inches wide octagonal box, unless otherwise noted.

D. Masonry Boxes: Galvanized steel with gang capacity and extension ring covers to match the number of devices installed.

2.2 JUNCTION, PULL AND SPLICE BOXES

A. Galvanized steel boxes conforming to NEC Article 370.

B. Use NEMA 1 type boxes at least 4 inches deep, interior spaces.

C. Use NEMA 3R type boxes at least 4 inches deep, exterior spaces.

D. Use NEMA 4 cast iron type with external recessed flanged cover when cast in concrete.

2.3 MANUFACTURERS

A. Appleton

B. Eaton

C. Hoffman

D. Hubbell

E. Keystone

F. Lew

G. Orbit Industries

H. Raceway Components

I. RACO

J. Stahlin

K. Steel City

L. Thomas & Betts

M. Walker

PART 3 EXECUTION

3.1 OUTLET BOXES

3.1.1 GENERAL

A. The definition of an outlet, as it is used in this section, is to be per article 100 of NEC.

B. Provide all standard boxes, pull junction, wiring device and/or splice boxes for all systems in walls and slabs.

C. All low voltage systems in attic or crawl spaces specified in Division 23 are not included.

D. At all ceiling-mounted receptacle and luminaire (exit light, pendants, linear direct/indirect, etc.) locations, provide a heavy duty dual bar hanger with ceiling ties to support the back box. Provide Cooper Industries BA50F or approved equal with appropriate back box for the application.

E. All outlet boxes shall be mounted between joists and supported by both adjacent joists/studs, not just one. All outlet boxes shall be supported by a rigid box support or mounting bracket that stretches the entire length between the joists/studs and is mechanically fastened to joists/studs at each end. Outlet boxes shall not be supported from only one side or by only one joist/stud regardless of stud material. Provide a caddy H23, SGB, TSGB, RBS or similar product.

3.1.2 FLUSH BOXES

A. Mount all outlet boxes flush within 1/4 inch of the finished wall or ceiling line unless otherwise indicated. Provide knockout closures to cap unused knock out holes where knock out holes have been removed. Install outlets flush with finish walls or ceiling surfaces for concealed wiring.

B. Provide galvanized steel extension rings where required to extend the box forward in conformance to NEC requirements. Attach ring with at least two machine screws. Install electrical boxes and fittings in compliance with NEC requirements and in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes.

C. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring. Install blank cover plates, painted to match surrounding, at pull boxes, junction boxes and all others to which no fixture or device is to be attached.

D. Securely fasten outlet boxes in position using clips or other suitable means. Secure boxes rigidly to the substrate upon which they are being mounted. Solidly embed boxes in concrete or masonry. Boxes shall not be permitted to move laterally, or to be supported only by EMT or conduit.

E. Provide plaster rings for all boxes in plastered walls and ceilings.

F. Where more than one switch occurs at the same location, use multiple gang outlet boxes covered by a single plate. Separate switches ganged in one box by a grounded metal barrier where system voltage exceeds 150 volts to ground. Fittings shall be approved for grounding purposes or shall be jumpered with a copper grounding conductor of appropriate ampacity. Leave terminations of such jumpers exposed. Use masonry type boxes with square corners in unplastered tile walls to allow tile to be sawed out neatly around box. Plates shall cover any cracks between box and tile. Use oversize plates where necessary.

3.1.3 LIGHTING FIXTURE BOXES

A. Do not install boxes for suspended lighting fixtures which are attached to and supported from suspended ceilings. Coordinate all lighting fixture outlets with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation. Install approved 3/8" fixture studs in outlets from which lights are suspended, fastened through from back of box. Anchor outlet boxes and particularly those supporting fixtures, securely in place in an approved manner. Support outlet boxes and fixtures from building structures, not from ceiling material. Provide yokes, channels, studs or other supporting materials as required.

B. At all exit luminaires installed in grid ceilings (T-grid), provide a Cooper Industries BA50F or approved equal.

3.1.4 WALL MOUNTING HEIGHT

A. Mounting height of a wall-mounted outlet box means the height from finished floor to bottom of box.

B. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation.

C. Remove and relocate any outlet box placed in an unsuitable location.

3.1.5 BACK-TO-BACK BOXES

A. Do not connect outlet boxes back to back unless prior approval from Engineer is obtained.

B. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.

3.1.6 BOX OPENINGS

A. Provide only the openings necessary to accommodate the conduits at each individual location.

3.2 JUNCTION, PULL AND SPLICE BOXES

3.2.1 INSTALLATION

A. Install boxes as required to facilitate cable installation in raceway systems.

B. Provide boxes in conduit runs of more than 100 feet or as required in Division 26.

C. Locate boxes strategically and make them of such shape to permit easy pulling of wire or cables.

D. Locate exposed pull or junction boxes subject to the owner's representative's approval. Protect boxes in such a manner as to prevent foreign material, such as plaster, from entering boxes. Boxes shall be thoroughly cleaned of foreign materials before pulling conductors.

E. Install and support boxes per NEC 314-23 as required and as directed.

3.2.2 COVERS

A. Provide boxes so that covers are readily accessible and easily removable after completion of the installation.

B. Include suitable access doors for boxes above suspended ceilings.

C. Select a practical size for each box and cover.

D. Label covers with permanent "black" felt-tip marker. Circuit numbers shall be provided on power covers.

E. Fire alarm covers to be red in color, Steel City part number 52-C-1RD or equivalent.

3.3 LOCATION OF BOXES

A. The approximate location of boxes for switches, light outlets, power outlets, etc. is indicated on the plans. These drawings, however, may not give complete and accurate information in regard to locations of such items. The exact locations shall be determined by reference to the general building plans and by actual measurements during construction of the building, subject to the Architect's approval.

B. The Owner's representative reserves the right to make reasonable changes, up to six feet, in the indicated locations before work is roughed in, without additional charge.

C. Unless otherwise shown or specified, install boxes for switches 44" and receptacles 18" above finished floor. Verify all door swings with the drawings and schedules and locate switches and pull stations, unless specifically noted otherwise, on the strike side of the door. If switch is indicated on hinged side of door, verify location with the Owners Representative.

D. Where shown near doors, install wall switches shall be ganged in multiples as required covered by a single multigang cover plate. Where convenience outlets, telephone outlets, or data processing equipment outlets are near each other, outlet boxes shall be joined or otherwise placed so that they are all the same level. Device plates shall match for all outlets.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

1.1.1 SECTION INCLUDES

A. Identification required for electrical systems.

B. Code required identification not shown on plans nor specified herein shall be provided.

1.1.2 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Division 26, Section 26 00 00, apply to this Section.

B. See the following sections for related work.
1. Section 26 00 00 - Electrical
2. Section 26 00 90 - Electrical Submittal Procedures
3. Section 26 24 16 - Panelboards for Distribution Switchgear
4. Section 26 28 16 - Enclosed Switches and Circuit Breakers

1.2 SUBMITTALS

1.2.1 PRODUCT DATA

A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1 and Division 26, Section 26 00 90 requirements.

B. Submit product data for sign materials. Refer to Electrical Identification detail on drawings for additional information.

1.2.2 QUALITY ASSURANCE/CONTROL SUBMITTALS

A. After the owner's room number list is finalized, submit a list of all electrical identification tags. The list shall include the actual text that will appear on each tag. Include the owner's and architects room numbers on all tags. This list shall be submitted for the review of the owner and architect.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sign Materials:
1. Type:
   a. Engraving-Stock
   b. Melamine plastic laminate
2. Thickness:
   a. Less than 25 square inches:
      (1) 1/16 inch

b. 25 square inches or more:
(1) 1/8 inch
3. Color: Black Conform to FS L-P-287

B. Lettering:
1. Style: Engraved standard print, unless otherwise indicated.
2. Size: 3/16 inch to 1/4 inch
3. Color: White

2.2 SIGN INFORMATION

A. Panelboard (New):
1. Data:
a. Panelboard designation
b. Voltage, phase and wires
c. Source of service
2. Example:
a. CHAC
b. 277/480V., 3-phase, 4-wire
c. Fed from MDP

B. Switchboard:
1. Data:
a. Switchboard designation
b. Source of service
c. Panel type
d. Style
e. Amperage
f. Neutral amperage
g. Voltage of each branch circuit designation.
h. Phase and wires.
2. Example:
a. DPC - 277/480V.
b. 3 phase
c. 4 wire
d. Fed from MDP

C. Safety Switches:
1. Data:
a. Switch or load served designation.
b. Voltage and phase.
2. Example: In the following example, the text in parenthesis does not go on the actual tag. It is for clarification only.
a. #112 (Owner's Room Number)
b. A/C #C206 (Architect's Room Number)
c. Circ. CHAC-15
d. 480V.
e. 3 phase

D. Time Clocks:
1. Data:
a. Time clock load(s) served
b. Voltage and phase
c. Source of service
2. Examples:
a. Parking Lot Lights

b. 480V.
c. Single Phase
d. Fed from CH-15

E. Soffit Lights
1. 277V.
2. Fed from CH-21

F. Water Heater:
1. 208V.
2. Single phase
3. Fed from AL2-25

G. Electrical Riser Diagram Signs:
1. Material:
a. Provide laminated copy of electrical riser diagram and screw to wall in each electrical room.
2. Size:
a. Minimum: 12" x 17"
b. Maximum: 30” x 42”
3. Provide a riser diagram in each electrical room similar to the riser diagram shown on the plans, and/or as required for the area served.

H. Device Engraving:
1. Any switch for load that is not in sight of the equipment served: custom engrave on outside of switch cover plate.
2. Custom engrave switch function when called for on the plans.

I. Panelboard Directory:
1. For each panelboard, provide a directory-frame mounted inside the door with heat-resistant transparent face and a directory card for identifying the load served.
2. Identify circuits by equipment served on by room numbers where room numbers exist. Room numbers shall be as directed by Owner.
3. Verify nomenclature at job site.
4. Directory shall be typed, shall coordinate with panel breaker and be neat.
5. Indicate spares and spaces with erasable pencil.

J. Refer to Section 26 24 16 (Panelboards for Distribution Switchgear)

K. Nameplate Fasteners:
1. Securely attach nameplates to equipment with non-corroding stainless steel screws.
2. Non-corroding pop rivets are acceptable.
3. Stick-ons or adhesives will not be allowed.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate with the architect to obtain a list of the finalized owner’s room number list.

B. Prepare the quality control submittal of tag data as described in the Submittals article of this specification.

C. After the submittal has been reviewed without comment by the architect and the owner, proceed to order the identification tags.

D. Tags with incorrect data that have not been reviewed without comment by the architect and owner do not comply with these specifications.

3.2 INSTALLATION

A. Provide signs for equipment requiring identification as shown on drawings and for equipment as required by National Electric Code.

B. Provide for each main disconnect not grouped together.

C. Refer to Section 26 28 16 for Enclosed Switches and Circuit Breakers.

D. Install signs on outside of cover for safety switches and time clocks.

E. Install signs on outside top, not on door, and at each circuit for panelboards, switchboards and motor control centers.

F. Label spares and blank spares in light, erasable pencil.

G. Mount in an easily visible location.

H. All labeling identification shall contain both the owner's and architect's room names and numbers. Coordinate with General Contractor to secure construction room numbers.

I. Provide all additional signage required by local authority at no cost to the Owner.

END OF SECTION

SECTION 26 08 11

TESTING OF ELECTRICAL SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Complete testing and evaluations to assure that the electrical system is installed for proper operation.

1.3 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems

D. Section 26 27 26 - Wiring Devices

1.4 REFERENCES

A. Biddle Instruments #21-P8a - Electrical Insulation Testing

B. Biddle Instruments #25Ta - Earth Resistance Testing

1.5 COORDINATION

A. Coordinate special tests and/or equipment start-up as specified or implied in related sections.

1.6 SUBMITTALS

A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements. Included in this section are megger tests of all main feeders to all switchboards and/or panelboards. Submit tests of insulation resistance, conductor resistance, and ground resistance.

PART 2 PRODUCTS

A. Not used.

PART 3 EXECUTION

3.1 TESTING

A. Perform in accordance with manufacturer's printed testing procedures, applicable industry standards, ANSI standards, IEEE standards, NEMA standards and as directed by the

Engineer. Provide testing equipment in good working order and which complies with the applicable industry standards and manufacturer's requirements. Include a list of testing equipment used and date of last calibration.

B. Test the following:
   1. Feeder conductors from switchboard to panelboards.
   2. Grounding of the Electrical system neutral: Ground resistance shall not exceed 10 ohms.
   3. Equipment grounds for each feeder: Ground resistance shall not exceed 25 ohms.
   4. Insulation resistance: Ground resistance shall not be less than one (1) megohm.

C. Perform all tests in the presence of the Engineer, Architect or the Owner in accordance with the forms included in this section.

D. Submit each test form within ten (10) working days from the time the test is performed.

E. Document all test results and provide a signed report by the testing technician as witnessed. Reports shall include date, time, weather conditions, field conditions, test data, instruments used and brief description of the test. Include reports in operating manuals. Submit tests.

Job Name: _____

Person and Company Conducting Test: _____

Signature of Person Conducting Test: _____

Insulation Test Results (Megger)

Feeder Description	Test Date	Resistance (megohms)	Remarks

Notes:
1. Test shall be conducted after conductors are pulled.
2. Ground resistance on insulation shall be no less than one (1) megohm.
3. Make copies of this form if more blanks are needed.

Job Name: _____

Person and Company Conducting Test: _____

Signature of Person Conducting Test: _____

Transformer Test Results

Transformer	Test Date	Secondary Voltage	Tap Setting	Grounding of Transformer Neutral (ohms)	Remarks

Notes:
1. Test on transformer neutral and tap settings shall be performed at time of substantial completion.
2. Ground resistance of transformer neutral shall be no greater than ten (10) ohms.
3. Make copies of this form if more blanks are needed.

Job Name: _____

Person and Company Conducting Test: _____

Signature of Person Conducting Test: _____

Feeder Ground Test Results

Feeder	Test Date	Resistance (ohms)	Remarks

Notes:
1. Test shall be conducted at time of substantial completion.
2. Ground resistance shall not exceed 25 ohms.
3. Make copies of this form if more blanks are needed.

Job Name: _____

Person and Company Conducting Test: _____

Signature of Person Conducting Test: _____

System Neutral Ground Test Results

Feeder	Test Date	Unbonded resistance (megohms) see note 1	Bonded resistance (ohms) see note 2	Remarks

Notes:
1. Neutral is not bonded to equipment and/or ground at any location. Resistance shall not be less than one (1) megohm.
2. Neutral is connected to ground at transformer only. Resistance shall not exceed 25 ohms.
3. Test shall be performed at time of substantial completion.
4. Make copies of this form if more blanks are needed.

END OF SECTION

SECTION 26 24 16

PANELBOARDS FOR DISTRIBUTION SWITCHGEAR

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. Switchboards

B. Branch circuit panelboards

C. Switchgear

1.3 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems

D. Section 26 05 33.11 - Raceways and Conduits for Electrical Systems

E. Section 26 28 13 - Fuses

F. Section 26 43 00 - Surge Protective Devices (SPD)

1.4 REFERENCES

A. UL 50 - Cabinets and Boxes.

B. UL 67 - Electric Panelboards.

C. NEMA AB1 - Molded Case Circuit Breakers.

D. NEMA AB2 - Procedures for Verifying the Performance of Molded Case Circuit Breakers.

E. NEMA PB1 - Panelboards.

F. NEC - NFPA 70 National Electrical Code 2017

1.5 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

A. For any project where service entrance equipment is added or changed, provide a short circuit/coordination study for the entire system.

B. For any project where electrical panels are added or changed but the service entrance equipment is not changed, provide a short circuit/coordination study for the service entrance equipment and all affected panels.

C. For any project involving mechanical equipment changes including chillers, cooling towers, air handlers, condensers, pumps, or rooftop units, provide a short circuit/coordination study for the affected portion of the system including affected panels and branch circuit overcurrent protective devices to the HVAC equipment.

D. For any project where service entrance equipment and electrical panels are added, provide a short circuit/coordination study for all service entrance equipment and panels.

E. Submit the short circuit/coordination to the city. The level of detail and format shall conform to city requirements.

F. Coordinate the short circuit current ratings of mechanical equipment with the available short circuit current. The short circuit current ratings of all electrical and mechanical equipment shall exceed the available short circuit current.

G. Adjust settings of adjustable circuit breakers to achieve selective coordination of the system. Notify the engineer if selective coordination cannot be achieved.

1.6 ARC FLASH HAZARD STUDY

A. For any project where service entrance equipment is added or changed, provide an arc flash/fault study and all required labels for the new service entrance equipment per NEC 110.16 and 110.21(B).

B. For any project where electrical panels are added or changed but the service entrance equipment is not changed, provide an arc flash/fault study and all required labels for all affected panels per NEC 110.16 and 110.21(B).

C. Install all required labels on all service entrance equipment and electrical panels per the above NEC references.

1.7 DESCRIPTION OF WORK

A. All panelboards with 400 amp main circuit breakers, 400 amp main lugs or 400 amp fused and larger shall be factory assembled.

B. The Contractor shall furnish and install approved panelboards of the types indicated and specified herein at locations as shown on the drawings.

C. Interiors shall be completely factory assembled.

D. Where this specification conflicts with panelboard schedules, contact the Engineer for clarification.

1.8 SUBMITTALS

A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements.

B. Provide shop drawings for each electrical equipment room showing the placement of all panelboards, transformers, and other equipment such as mechanical equipment, drawn to scale and dimensioned. Such shop drawings will be reviewed for compliance with the intent of the contract drawings and the spaces available for the electrical apparatus.

C. Clearly indicate on the submittals whether equipment is fully rated or series rated.

D. Arrangement: Arrange panelboard submittals in the order the panelboard schedules appear on the panelboard sheets of the drawings as read from top to bottom, then left to right.

PART 2 PRODUCTS

2.1 ENCLOSURE

A. Minimum 16 gauge cold-rolled sheet steel. Gutter wiring space shall be a minimum of 4 inches on each side/industry standard. Provide standard conduit knockouts in ends and sides of cabinet. Provide flush type combination catch and key door locks on all panelboards and load centers. Key all locks alike, provide two keys with each panelboard.

B. Flush mounted panelboards trims shall fasten to permit both horizontal and vertical adjustment.

C. Surface mounted panelboards trims shall fasten to insure no overhang.

D. Bus Material shall be:
   1. Phase Bus: 98% IACS conductivity copper with rounded edges, tin electro-plated.
   2. Ground Bus: 25% phase rated, additional isolated bus in computer and communication panels.
   3. Neutral Bus:
      a. 200% of phase rated copper, tin electro-plated - computer panels
      b. 100% of phase rated copper, tin electro-plated - lighting and power panels
   4. Current density to be the industry standard.

E. Install in allotted spaces so that devices can be added without additional machining, drilling or tapping.

F. Brace to withstand symmetrical short circuit current as indicated on drawings.

G. Provide NEMA 3R panelboards where exposed to weather, with weatherproof threaded hubs for top/bottom/side conduit entries into panel.

2.2 CIRCUIT BREAKERS

A. Quick-make, quick-break. Manual and automatic operation. Trip free and trip indicating.

B. All switchgear bolt-on only. Number of poles and ampere ratings indicated for the specified service.

C. Interrupting Ratings: As indicated on panel schedules. Panels may be noted on the drawings as fully rated due to excessive motor loads. Otherwise, panels can be fully rated or series rated for construction of new buildings. For addition and renovation work, panels with main breakers can be fully rated or series rated unless noted on the drawings as fully rated. Main lug only panels for addition and renovation work shall be fully rated.

D. Bimetallic overload elements. Magnetic trip. Common trip type so that an overload or fault on one pole will trip all poles simultaneously. Handle ties are not acceptable.

E. Connect to the main bus by means of a solid connection. Use breakers which are capable of being operated in any position within the panel.

F. Independently mount so that a single unit can be removed from the front of the panel without disturbing or removing main bus, other units or other branch circuit connections.

G. Provide ground fault circuit breakers (GFCI) where indicated on the plans, panel schedules and/or as required by NEC 422.5, 210.8(B), etc. Provide protection at all EWCs, vending machines, kitchen equipment, concessions equipment, etc.

H. Provide HACR listed circuit breakers on all HVAC equipment 60 amps or less.

I. All circuit breakers that have an overcurrent trip setting fixed or adjustable to 1200A or higher shall have an Energy-Reducing Maintenance Switch or similar approved method for arc energy reduction and shall meet all requirements of NEC 240.87.

J. Where AFCI protection is required per NEC 210.12, provide combination AFCI circuit breakers.

2.3 CIRCUIT IDENTIFICATION

A. Frame-mounted directory with a heat-resistant transparent face for identifying circuits. Use equipment names as reflected by Engineer. Use numbers selected by the Owner, which may differ from those shown on plans.

B. Indicate with light, erasable pencil marking, all spares and spaces.

C. Provide on all panelboards, revise existing panelboards per Division 26 with new information.

D. Mount inside the panelboard door.

2.4 SURGE PROTECTION

A. Provide a surge protective device at the main switchgear in accordance with section 26 43 00.

2.5 IDENTIFICATION OF SWITCHGEAR

A. Information shall include the following:
   1. Panel type
   2. Style
   3. Amperage
   4. Neutral amperage
   5. Panel voltage
   6. Phase
   7. Number of wires

B. Provide information on each piece of equipment, on factory or contractor made nameplate.

2.6 MANUFACTURERS

A. ABB (GE)

B. Square D (Preferred)

C. Siemens

D. Eaton Corporation (formerly Cutler-Hammer) (Preferred)

PART 3 EXECUTION

3.1 INSTALLATION

A. When isolated ground devices are shown being powered from a panel, provide a complete isolated ground system including isolated ground panel with 200% neutral, SPD and separate isolated ground bus.

B. Install in the locations as shown and as recommended in NEMA PB1.1. Mount the panelboards such that the center of the switch or circuit breaker in the highest position will not be more than 6-1/2 feet above the floor or working platform. Space all panelboards and switchboards to meet the requirements of Article 110 and 340 of the N.E.C. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secured.

C. Provide required SPD breaker for each panel/switchboard as required by the manufacturer.

D. Provide a sign at each switchboard 1600 amp and greater, which reads "Danger High Voltage" in red/white/black.

E. Install panelboards and enclosures, including electrical connections, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the NECA "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended function.

F. Coordinate installation of panelboards and enclosures with cable and raceways installation work.

G. Connect A, B and C phases respectively to bus number 1, 2 and 3 from left to right or top to bottom. Balance panels by checking each phase of all panels under full load and arrange so that all phases carry the same load as near as possible.

H. Furnish and install an engraved laminated nameplate for each circuit breaker or fused switch in distribution panelboards. Refer to electrical equipment identification section of the specifications. Place free standing or floor mounted equipment on housekeeping pads.

I. Series rated panels: Field mark the factory furnished label in accordance with NEC Article 110.22(C).

3.2 INSTALLATION OF CONDUCTORS

A. More than one conductor shall not be installed in any termination in a panelboard unless the termination is marked as suitable for more than one conductor.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 26 00 00, apply to this Section.

1.2 SECTION INCLUDES

A. AC Switches

B. Receptacles

C. Connectors

D. Finish plates

E. Relays

1.3 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems

D. Section 26 05 33.13 - Boxes and Fittings for Electrical Systems

1.4 REFERENCES

A. ANSI/UL 20 - General - Use Snap Switches

B. ANSI/UL 498 - Electrical Attachment Plugs and Receptacles

C. UL 943 - 2006 - Ground Fault Circuit Interrupters

D. NEMA WD 1 - General - Purpose Wiring Devices

E. NEC - National Electrical Code

F. Applicable Federal Specifications - WC - 596-F, WS-896E

G. Mounting heights per Americans with Disabilities Act

1.5 SUBMITTALS

A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1, and Division 26, Section 26 00 90 requirements.

B. Product Data: Clearly mark product data for each product specified and/or proposed for use. Product cut sheet data shall include, but not limited to the following:
   1. receptacle devices
   2. switch devices
   3. isolated ground receptacle devices
   4. weatherproof receptacles
   5. device plates
   6. enclosures
   7. keys
   8. cord reels

1.6 DESCRIPTION OF WORK

A. Provide factory fabricated wiring devices of the type and electrical rating for the service indicated, provide proper selection to fulfill the wiring requirements. Wiring devices, including receptacles and switches shall be colored to match wall plates. Special purpose outlets shall be of appropriate color.

B. Provide a compatible receptacle for the cap or plug and cord of all other equipment installed in this project.

C. Relays, if any, shall be multipole, mechanically held, 30 amperes 120V operating coil, 600V contacts, auxiliary contacts as required for two wire operation, coil clearing contacts: Zenith ESS Series or equal.

D. Provide switch, receptacle, outlet, conduit, and special purpose wall plates for wiring devices, with ganging and cutouts as indicated, provided with metal screws for securing plates to devices, screw heads colored to match finish of plate.

E. Provide oversize plates where required to completely cover wall opening. Where oversize plates are used, all plates in room shall be oversize style.

F. Use plates and Raco narrow gang boxes in storefront mullions and where narrow boxes are required.

G. Mount all switches, thermostats, etc. at the same height when located horizontally within 6 feet on same wall. See mechanical drawings for thermostat locations.

PART 2 PRODUCTS

2.1 AC SWITCHES

A. Quiet-type, specification grade, heavy duty, back and side-wired with grounding terminals. Furnish AC switches which comply with NEMA WD-1 Standards, UL20 and Federal Specification WC896. Special purpose switches shall be of appropriate color. Switches shall be rated for 120-277 volt AC, number of poles as required.

B. Provide 120/277 volt NEMA 5-20 self-grounding specification grade devices only.

C. Provide 20 ampere ratings for all loads. Rated amperage capacity shall be 100% for all lighting loads, and 80% for all motor loads.

D. Single Pole:
   1. Leviton 1221-S
   2. Hubbell CS1221
   3. P&S CSB20AC1

E. Double Pole:
   1. Leviton 1222-S
   2. Hubbell CS1222
   3. P&S CSB20AC2

F. Three Way:
   1. Leviton 1223-S
   2. Hubbell CS1223
   3. P&S CSB20AC3

G. Four Way:
   1. Leviton 1224-S
   2. Hubbell CS1224
   3. P&S CSB20AC4

H. Motor Rated Switches:
   1. 20A. 2P Motor: 20AC2-HP (6806U-DAC);
   2. 30A. 2P Motor: 30AC2-HP (6808U-DAC);
   3. 30A. 3P Motor: 7803 (7810-UO);

I. Wall Timer Switches:
   1. Watt Stopper TS-400 with optional flash warning
   2. Equals by P&S RT24 series.
   3. Paragon will not be accepted.

2.2 RECEPTACLES

A. Furnish receptacles which comply to NEMA WD-1 Standards, UL 498 and Federal Specification WC596F.

B. GFCI Receptacles: 20-amp, duplex. Comply with NEMA WD 1, NEMA WD 6, UL 498, Federal Specification W-C-596, and UL943, Class A. Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following:
   1. {Pass & Seymour; 2097, 2097 (NAFTA Compliant), PT2097 (use with PTRA6STRNA prewired pigtail connector), PT2097NA (NAFTA Compliant - use with PTRA6STRNA prewired pigtail connector).}{Hubbell GFRST83.}
   2. Equivalent by Leviton

C. Isolated Ground:
   1. 5-20R, Leviton 5362-IGI with Orange triangle. See Device Color article below for required color.
   2. Provide at all computer/communications locations.
   3. Four wire with self-ground mounting strap.

D. Clock Outlet: Leviton 5361-CH, P&S S3733SS

E. Weatherproof Receptacles:
   1. Provide GFCI receptacle as specified above.
   2. Receptacle covers protected from rain shall be zinc die-cast weather-resistant cover with self-closing lid, Leviton 4992, P&S WIUCAST1, or equivalent.

3. Receptacle covers not protected from rain shall be “While-In-Use” cover, Leviton 5977DGY, P&S WIUC10DGL, or equivalent.
4. Do not use feed through feature for any GFCI receptacle.
5. Install separate GFCI device at each location.

F. Controlled Receptacles - Leviton CR020 series or equivalent
1. All controlled receptacles required to meet IECC shall be duplex receptacles with the top receptacle controlled and the bottom receptacle non-controlled, unless otherwise noted on the drawings.
2. All controlled receptacles shall meet NEC 406.3(E) 2017 (or newer) marking requirements.

2.3 DEVICE PLATES

A. In finished spaces use stainless steel device plates and covers.

B. At exposed boxes in dry interior spaces use heavy cadmium-plated sheet steel. Plate edges must be flush with edges of boxes.

C. Device plate manufacturer and device manufacturer shall be the same so colors will match. Stainless steel plates will not match the device.

2.4 DEVICE COLOR

A. Device color to be white, except as otherwise indicated or required by code.

2.5 MANUFACTURERS

A. Products to be equivalent to the manufacturer, Pass & Seymour (P&S), and model numbers listed in this section. Subject to compliance with requirements, provide products by one of the following:
1. Eaton Corp. (Arrow Hart Division - formerly Cooper Industries)
2. Bryant
3. Coxreels
4. Hubbell Inc. - Richard Prather, 512-795-4058 x8325
5. KH Industries - Wendy Caparco, 716-312-0088 x144
6. Leviton MFG. Co., Inc. - Jordan Steele, 214-683-1438
7. Pass & Seymour/Legrand/Wiremold - Tracey Cain, 214-683-9726

2.6 POWER/DATA RACEWAY DEVICES

A. Provide all telecommunications and data plates in power/data raceways as specified and noted on Communications Drawings. Devices to be compatible with power/data raceways as specified in Section 26 05 33.11.

PART 3 EXECUTION

3.1 INSTALLATION

A. Wall Switches:
1. Install in a suitable outlet box on the strike side of the door.
2. Mount at a height of 44" from the finished floor to the bottom of the switch.
3. Position switches in a uniform position so that the same direction of operation will open and close the circuits throughout the job. Position up or to the left for the ON position.

4. Do not install behind markerboards, millwork, permanent mounted equipment, etc. Verify on drawings before installation. Where installed in unsuitable location, the Contractor will move as directed at no cost to Owner.
5. Prewired pigtail connectors that accommodate UL Fed Spec receptacles are approved for installation. P&S PlugTail or equal.

B. Receptacles:
1. Install in a suitable steel outlet box.
2. Mount vertically at a height of 18 inches from the finished floor to the bottom of the receptacle or as shown on the drawings.
3. The Architect can move any receptacle, before installation, up to 6 feet in any direction at no additional cost.
4. Do not install behind markerboards, millwork, permanent mounted equipment, etc. Verify on Architectural drawings before installation. Where installed in unsuitable location, the Contractor will move as directed at no cost to Owner.
5. Prewired pigtail connectors that accommodate UL Fed Spec receptacles are approved for installation. P&S PlugTail or equal.
6. Provide AFCI protection per NEC 210.12.

C. Tamper resistant receptacles: Provide tamper resistant receptacles in the following spaces in accordance with 2017 NEC / 2020 NEC article 406.12.
1. Dwelling and multifamily dwelling units
2. Guest rooms & suites of hotels, motels & common areas.
3. Child Care facilities or spaces
4. All spaces in preschool and elementary schools.
5. Offices, corridors, and waiting rooms of clinics, medical and dental offices, and outpatient facilities.
6. Gyms, auditoriums, conference rooms, dining areas, and multipurpose rooms, and assembly areas of places of worship.
7. All spaces in dormitories.
8. Exceptions: See NEC article 406.12 for exemptions.

D. Device Plates:
1. Install device plates for each outlet box of the type required for service.
2. Use a single one-piece device plate for ganged devices (switches & receptacle).
3. Use separate device plates for dimmers, volume controls and electronic devices.

E. Cord Reels:
1. Install cord reels per cord reel detail or plan notes on the drawings.
2. Where a cord reel is required to be installed above a ceiling, mount cord reel such that roller assembly protrudes slightly through the ceiling. Provide trim plate at ceiling cutout. If above ceiling space is plenum rated, cord reel must be installed in a box so it is not in the plenum space.

F. Poke-Thru Devices:
1. Provide and install all wiring, devices, covers, plates, conduit and hardware as required for a complete installation. Do not daisy-chain poke-thru devices with conduits unless otherwise noted on drawings.
2. Wiremold Evolution 8AT. Provide and install three duplex outlets and associated wiring per general notes on drawings. Provide isolated-ground outlets if indicated by symbol on drawings. Provide power to outlet using circuits shown on plans.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 GENERAL

1.1 SUMMARY

A. This section supplements section 26 00 00 - Electrical and contains additional requirements applicable to fuses.

1.2 SECTION INCLUDES

A. Low voltage fuses rated below 600 volts and 2000 amperes.

1.3 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 00 90 - Electrical Submittal Procedures

1.4 SUBMITTALS

A. Submit product data for fuses in accordance with Section 26 00 90 Electrical Submittal Procedures.

1.5 QUALITY ASSURANCE

A. Prior to ordering fuses or fuse holders, coordinate fuse ratings with the mechanical contractor to verify that fuses for HVAC equipment matches the MOCP values of the HVAC equipment being provided.

1.6 EXTRA MATERIALS

A. Spare fuses: For each size and type fuse installed, provide to the owner at substantial completion six each or 10% of the quantity used on the project, whichever is less.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. All fuses shall be from a single manufacturer. Products of the following manufacturers are acceptable.
   1. Bussman
   2. Littelfuse
   3. Mersen (formerly Ferraz Shawmut)

2.2 MANUFACTURED UNITS

A. 600-amp and less: Class RK-1 dual element, time delay.

B. 601-amp and larger: Class L or J

PART 3 EXECUTION

3.1 INSTALLATION

A. Check fasteners on fuse clips for tightness when installing fuses.

B. Install fuses so label is in an upright, readable position. Fuses without labels are not acceptable.

C. Do not install fuses until equipment is ready to be energized.

D. Fuse cabinet: For new buildings only, provide a fuse cabinet in the main electrical room. Cabinet to be lockable with depth equal to largest fuse provided. Minimum of 24" W x 24" H x 4" deep.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

1.1.1 SECTION INCLUDES

A. Safety Switches

B. Disconnect Switches

1.1.2 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 00 90 - Electrical Submittal Procedures

C. Section 26 05 53 - Electrical Identification

D. Section 26 28 13 - Fuses

E. Section 26 43 00 - Surge Protective Devices (SPD)

1.2 REFERENCES

A. ANSI/UL 98 - Safety Standard for Enclosed Switches.

B. NEMA KS 1 - Enclosed Switches.

1.3 SYSTEM DESCRIPTION

A. Safety switches shall be of the same manufacturer as distribution switchgear.

B. Both the safety switch and disconnect are to indicate the requirement for a fused disconnecting means, unless a non-fused disconnect is specifically requested on the contract drawings.

C. The extent of safety switches, disconnect switches is indicated on the drawings and by the requirements of this section.

D. In accordance with the service indicated, use 240 or 600 volt switches, single throw, fusible, or non-fusible, horsepower rated, 100% load break and make rated, designed for locking in "ON" or "OFF" position, in code gauge steel cabinets, as required by the application and the N.E.C.

E. Use switches which have number of poles required, dependent on equipment requirements.

F. Use NEMA 3R switches where exposed to weather, with weatherproof threaded hubs for top or side conduit entries into switch.

G. Use fuse clips which are rejecting type to accept Class RK or L fuses only.

H. Size fuses serving motor loads at 125% to 175% of motor nameplate rating, or the next standard size and as specifically recommended by motor or equipment manufacturer.

I. Provide a manual switch at each motor, class 2510 Square D, for motors shown with "MS." Provide a 20-AMP rated switch at each motor not otherwise noted.

J. Where switches/breakers are listed as requiring GFCI protection in specifications or drawings, coordinate with the equipment manufacturer to provide proper GFCI requirements to determine whether they are intended to be for personnel (5ma) or equipment (30ma).

1.4 SUBMITTALS

A. Submittals required in this section shall conform to and be submitted in accordance with the General Conditions, Division 1 and Division 26, Section 26 00 90 requirements.

1.5 PRODUCT DATA

A. Submit product data for the following.
   1. Safety and Disconnect Switches

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. GE / ABB

B. Square D (Preferred)

C. Siemens

D. Eaton Corporation (formerly Cutler-Hammer) (Preferred)

2.2 SWITCHES

A. Provide safety switches and disconnects with a voltage rating suitable for the nominal voltage of the system in which they are to be applied. Contacts are quick-make, quick-break.

B. Provide surge protective devices in accordance with section 26 43 00.

2.3 CIRCUIT BREAKERS

A. All circuit breakers that have an overcurrent trip setting fixed or adjustable to 1200A or higher shall have an Energy-Reducing Maintenance Switch or similar approved method for arc energy reduction and shall meet all requirements of NEC 240.87.

2.4 CONSTRUCTION

A. Indoor dry locations, 30 amp thru 100 amp, use NEMA 1 general duty (GD).

B. All outdoor locations use NEMA 3R heavy duty (HD).

C. The handle shall be suitable for padlocking in the OFF position. Defeatable, front accessible, coin-proof door interlock to prevent opening the door when the switch is in the ON position and to prevent turning the switch ON when the door is open. Incoming line terminals with an insulated shield.

D. Provide switches with rejection-type fuse holders suitable for use with fuses specified under Section 26 28 13.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mount switches no more than 6 inches above and within 6 feet of the equipment served at the direction of the Engineer, so that operating handle is easily accessible. Align tops of switches when grouped together.

B. Provide a housekeeping pad for all free standing or floor mounted safety switches whether they are mounted inside or outside.

C. Mount vertically on required separate support system hardware with switch easily accessible (door to open 90 degrees minimum).

D. Permanently mount safety switches from inside with plated or stainless bolts, toggle bolts or anchors.

E. Exposed mounting bolts, screws, etc. are not acceptable.

F. Permanently install fusible switches with class R fuse kits so that fuses are readable when looking at open switch.

G. Do not mount switches/disconnects to access panels or on nameplate data or equipment.

H. Installation of Conductors: Switches shall not be used as “junction boxes” between HVAC units (splicing or “pig tailing” is not permitted). The maximum number of conductors allowed per termination is determined by the manufacturer’s approved rating for each terminal or lug. Multiple conductor configurations shall be highlighted in the contractor’s submittal package. Exceptions to this rating must be obtained in writing from the engineer’s office on a case by case basis.

I. Coordinate and verify exact fuse sizes with mechanical contractor. Fuses shown on drawings are based on one manufacturer. Fuse sizes vary depending on manufacturer.

J. Identification: Refer to Section 26 05 53 for Electrical Identification. Provide nameplate identification on all HVAC equipment regardless of equipment location.

END OF SECTION

SECTION 26 43 00

SURGE PROTECTIVE DEVICES (SPD)

PART 1 GENERAL

1.1 SUMMARY

A. This section supplements section 26 00 00 Electrical and contains additional requirements applicable to surge protective devices.

1.2 SECTION INCLUDES

A. Surge protective devices (SPD) provided in accordance with NEC article 285.

B. SPD for phone, data, security and other systems.

1.3 RELATED SECTIONS

A. Section 26 00 00 - Electrical

B. Section 26 00 90 - Electrical Submittal Procedures

1.4 REFERENCES

A. NEC - NFPA 70 National Electrical Code, most current edition

B. UL 1449 - Underwriters Laboratories, UL 1449, Standard for Safety, Surge Protection Devices 4th Edition March 2016 Type 1, Type 2 and Type 3 Protectors

C. ANSI/IEEE C62: Complete C62: Complete 1990 Edition: Guides and Standards for Surge Protection

D. UL 497 Paired Conductor Communications Circuits

1.5 SUBMITTALS

A. Submit in accordance with Section 26 00 90 Electrical Submittal Procedures.

B. Product Data: Submit product data for all SPD used on this project. Provide evidence that SPD are listed to the most current edition of UL1449 by an OSHA approved safety testing agency (i.e. UL, ETL, or CSA). Provide a submittal package that includes specifications and 3rd party testing and listing letters.

1.6 WARRANTY

A. All surge suppression devices and supporting components shall be guaranteed by the installing contractor to be free of defects in materials and workmanship for a period of five years minimum excluding installation labor. Lightning damage to the SPD is not grounds for voiding any/all warranties of the SPD.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following.
   1. ACT Communications
   2. Eaton Corporation (formerly Cutler Hammer)
   3. Emerson - Liebert
   4. ABB (formerly GE Industrial)
   5. Mersen (formerly Ferraz Shawmut)
   6. Schneider Electric - Square D
   7. Surge Suppression - ILSCO

2.2 MANUFACTURED UNITS

A. Technology: Construction shall be metal oxide varister (MOV) componentry with bidirectional operation.

B. Protection Modes: Provide at least seven mode protection (L-N, L-G, N-G) with discrete protection elements on each mode.

C. Protection: Each SPD shall be protected upstream by a dedicated UL rated fuse or disconnecting means.

D. Filtering: Provide surge protection plus filtering of disruptive noises, EMI/RFI interference to >-40db from 3kHz to 1 MHz according to NEMA LS-1 Specification.

E. Listing and ratings: SPD shall be tested and performance rated per UL1449. Clamping voltage shall be clearly stated on both submittals and equipment installed.

F. Voltage ratings:

Rated Line Voltage	Maximum Continuous Operating Voltage (MCOV)	Voltage Protection Rating (VPR)
120/240; 120/208 volt	150 volts	700 volts (L-N, L-G), 1000 (L-L)
240/480; 277/480 volt	320 volts	1000 volts (L-N, L-G), 1800 (L-L)
480 volts (2 ph. Delta)	600 volts	1800 volts (L-N, L-G), 3000 (L-L)

G. Alarms and monitoring: Provide SPD with the following.
   1. LED indicator lights for power and protection status.
   2. Audible alarm, with silencing switch, to indicate when protection has failed.
   3. One set of dry contacts rated at 5A and 240V for remote monitoring of protection.

H. SPD at the electrical service entrance (main distribution panel or main service disconnecting means) shall meet the following additional criteria.
   1. Modular construction and field replaceable.
   2. Bus Bar connected for low impedance connections.
   3. UL rated as Type 1 and Type 2 SPD device
   4. SCCR: 200kAIC
   5. Nominal Discharge Current (I_n): 20,000 amperes (8 x 20 us waveform)
   6. Maximum Single Impulse Current rating: >135,000 amperes (8 x 20 us waveform) / mode.
   7. Repetitive Surge testing per IEEE C62.41.2 C3 10,000 amps: 20,000 impulses

I. SPD at electrical sub-panels shall meet the following additional criteria.
   1. Modular or System construction
   2. UL rated as Type 2 device
   3. SCCR: 100kAIC or no less than specified rating of the electrical subpanel.
   4. Nominal Discharge Current (I_n): 10,000 amperes (8 x 20 us waveform)
   5. Maximum Single Impulse Current rating: >65,000 amperes (8 x 20 us waveform) / mode.
   6. Repetitive Surge testing per IEEE C62.41.2 C3 10,000 amps: >2,500 impulses

J. SPD at rooftop units and condensers shall meet the following additional criteria.
   1. NEMA 4X enclosure suitable for outdoor installation
   2. Nipple-mounted
   3. SCCR: 100kAIC
   4. Squared D SDSA series or equivalent.

K. Receptacles with Type 3 SPD installed - Use only when one or two outlets need SPD and panel is not readily available:
   1. SPD in a receptacle is able to employ a maximum of two IEC 320 receptacles (NEMA 5-20R) and shall be rated not more than the current rating of the SPD and voltage rating consistent with the voltage rating of the SPD.
   2. A SPD receptacle used for outdoor use shall comply with the outdoor requirements in UL 498 and shall be provided with a receptacle hood which is weather-proof.
   3. Permanently wired with high visibility LED indicator and/or damage alert beeper
   4. Minimum Transient Suppression:
      a. MCOV and VPR matches section 2.2 B 4
      b. 6,500 amp peak current in each mode
   5. Manufacturers:
      a. Pass and Seymour 6262 Series
      b. Hubbell 8200 H Series
      c. Leviton 5300 Series
      d. Wiremold "Sentrex 52TB2" series

L. SPD for telephone, video, data and alarm lines shall meet the following criteria.
   1. Comply with appropriate UL 497, 497A, 497B and 497C standards for secondary protectors.
   2. Technology can be Gas Tube, Silicon Avalanche Diode or hybrid.
   3. Rate Line Voltage (RMS): 150V for phone, 24V for data and control.
   4. Maximum single line impulse 10,000 amps (8/20 us current waveform).
   5. Clamp Voltage (Pair): Tip to ground and Ring to ground: 300 volts
   6. Pulse Life: 1,000 - 3KA - 8/20 NS impulse with drift.
   7. Maximum Continuous Operating Voltage: 180 VAC tip to ground, 180 VAC ring to ground

PART 3 EXECUTION

3.1 INSTALLATION

A. For new construction, provide SPD at each of the following locations. For renovations and additions, provide SPD at the following locations which are affected by the project but do not already have SPD.
   1. Each electrical service entrance equipment.
   2. Each main computer panelboard and at each isolated ground panelboard.
   3. At all emergency systems switchboards and panelboards.
   4. At each panelboard noted on drawings in addition to above requirements.
   5. On all outdoor rooftop HVAC units and on all condensing unit switches. Mount to bottom of switch or as recommended by the manufacturer.

6. One SPD power outlet at each energy management control panel located by project controls contractor.
7. At each new telephone and data incoming line.
8. On all new video or alarm system wire entering from the outside of the facility.
9. In or on each fire pump controller in accordance with NEC 2017 Article 695.15.

END OF SECTION