

DIVISION 23 – MECHANICAL
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SECTION 23 0000 – BASIC HEATING, VENTILATION & AIR CONDITIONING (HVAC)
REQUIREMENTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. The General Conditions, Special Conditions, Instruction to Bidders and all applicable portions of Division 1 – General Requirements are part of this Section as if written in full herein. Contractor is held to have familiarized himself with these provisions contained therein.

PART 2 – SCOPE OF WORK

- A. The work included by these Specifications is intended to include the furnishing of all labor, materials and equipment required for, or reasonably incidental to, the complete installation of the heating, ventilating and air conditioning system as hereinafter specified and as indicated on the Drawings. The Contract Documents are complementary and what is called for by any one shall be as binding as if called for by all. Unless otherwise specifically stipulated, the term “Furnish and Install Complete” shall be considered a part of each Section.
- B. In general, the work shall include but not be limited to the following items:
1. Closed Circuit Cooling Tower
 2. Pumps
 3. Variable Frequency Drives
 4. Piping
 5. Insulation
 6. Controls
 7. Testing and Balancing

PART 3 – EXECUTION

3.01 PERMITS AND INSPECTIONS

- A. Contractor shall secure all required permits, shall pay for all inspections required by controlling authorities, and shall pay all charges in connection with his work.

3.02 SITE VISITATION

- A. It is strongly recommended that all Bidders visit and examine the site.
- B. No additional compensation will be awarded for deviations or discrepancies. Contractor shall become familiar with all conditions under which work must be performed, and shall check all present elevations.

- C. The Contractor shall report any major discrepancies to the Engineer. Failure to report such discrepancies shall be deemed acceptance of existing conditions.

3.03 ORDINANCES AND CODES

- A. All work shall be installed in accordance with the local regulations and State Codes and shall receive the approval of the inspection department having jurisdiction. The Drawings and Specifications constitute the minimum acceptable requirements.
- B. Should any work shown on the Drawings or herein specified be contrary to said minimum requirements, ordinances, statutes or regulations, the work shall be executed in accordance with the requirements, ordinances, statutes or regulations, but not until the points in question have been referred to the Engineer for approval.
- C. All tests shall be made as required by above mentioned requirements, ordinances, statutes or regulations, or by the inspector having jurisdiction. The cost of such tests shall be included in the Contract Price and evidence of such tests and inspections shall be provided for the Owner's files.

3.04 WARRANTY

- A. The Contractor shall warrant his workmanship and materials for a period of one (1) year from the date of final acceptance by the Engineer or beneficial use by the Owner, whichever occurs first. The work shall be left in perfect order at completion and should defects develop within the warranty period, the Contractor shall, upon notice of same, remedy the defects and reimburse the Owner for all damage to the other work, whether caused by the defects or the work of correcting same.
- B. By mutual agreement, the Owner may occupy or use a portion or portions of the work prior to total project completion. Acceptance of any work by the Engineer shall be accomplished by the issuance of a Certificate of Substantial Completion, a copy of which shall be promptly sent to the Contractor. From the date of issuance of such certificate, the Contractor shall be relieved of his obligation to maintain the portion of the premises accepted, but shall remain obligated to correct any "punch list" items uncorrected. The Contractor shall also continue to be responsible for all latent defects covered by the warranty described above, and shall continue to carry insurance to protect both the Owner and the Contractor's firm for workmen engaged on contingency items.

- C. Contractor should note that portions of this project may be used for temporary heating and plumbing and this shall not void or shorten the warranty period. Maintenance of equipment during construction shall be the responsibility of each Mechanical Contractor. All warranties, whether equipment, materials, etc., if used during construction or not, shall be under a warranty period of one (1) year after final acceptance of the project or beneficial use by the Owner, whichever occurs first. Any such defects noted during the warranty period shall be promptly rectified by the Contractor without expense and with a minimum of inconvenience to the Owner.
- D. The Contractor shall guarantee free and unrestricted flow of air and fluids without objectionable noise, and shall further guarantee all ducts, pipes and specialties to remain free from objectionable and/or substantial leaks during the warranty period.
- E. By entering into or accepting this Contract, the Contractor guarantees proper operation in accordance with the true intent of these Drawings and Specifications. If the Contractor is not satisfied that the requirements will make the guarantee possible, the Contractor shall submit with the bid a brief statement of such changes desired to have made therein which will enable the Contractor to give the guarantee.
- F. Certificates of approved final inspections by the authorities having jurisdiction shall be available for the Owner.

3.05 COMPLETION AND ACCEPTANCE

- A. When the Contractor is satisfied that all work required by Drawings and Specifications for the Contractor's division of the Contract has been completed, notification shall be given to the Engineer that this is substantially correct. The Contractor will be notified immediately as to acceptance or rejection of the notification.
- B. Upon acceptance of this notification, the Owner's Representative will conduct a final observation of the work (punch list) to determine what items remain in an unacceptable condition. A report of this observation will be delivered to the Contractor as soon as possible following acceptance of the Contractor's letter of completion.
- C. Upon receipt of the final punch list items, the Contractor shall take immediate corrective action on all items. When all items on the list have been corrected to the satisfaction of the Engineer, the final "Contract Completion Certificate" shall be executed. See General Conditions of these Specifications.

3.06 DRAWINGS

- A. In general, Drawings are schematic in nature, are intended as a guide to the Contractor, and do not necessarily show all details, offsets, etc. All Drawings are to be thoroughly inspected. For construction purposes, Drawings should not be scaled.
- B. The Contractor's work shall conform to the information contained in this Specification and/or as indicated in the latest revision to the Drawings referred to therein. The Contractor shall consult with the Engineer regarding all questions which may be in doubt before proceeding with fabrication of parts affected. The Contractor shall prepare all additional detail or field installation drawings necessary at the Contractor's own expense. The Contractor shall verify all dimensions and conditions indicated on the layout Drawings and determine if any changes are required in piping runs, drains, ducts, etc. to avoid interference. Major changes shall not be made without the approval of the Engineer.
- C. While the Drawings are to be adhered to as closely as possible, the Contractor has the right to vary the run of piping and/or ducts during progress of the work as may be found necessary or desirable to avoid interferences. Major revisions shall be verified with the Engineer.
- D. In general, the Specifications are written in the singular form. The Drawings should be used to determine the number of items required for a complete installation.

3.07 VERIFICATION

- A. Before running any ducts, piping, etc. within the building, this Contractor shall assure that they can be installed as contemplated without trapping or interfering with columns, beams, piping, fixtures, etc. Contractor to verify all measurements and conditions at job site before proceeding with the work. Any necessary major deviation shall be referred to the Engineer for adjustment before lines are run, at no increase in contract price.
- B. Of necessity, openings, supporting steel, field-built curbs, electrical data, space requirements, etc. were designed around specific parameters. When the Contractor determines the make of equipment to be provided for the job, it shall be the Contractor's responsibility to verify and coordinate unit dimensions with the General Contractor and all other interested Contractors on the job. It shall also become the Contractor's responsibility to change as necessary, through the Engineer, all required dimensions so that openings, supporting steel, curbs, electrical data, etc. will fit the equipment supplied. Any additional cost will be the sole responsibility of this Contractor.

- C. In addition, electrical power, interlock and control diagrams and piping arrangements were designed around one specific manufacturer. If additional wiring, piping, controls, etc. are required for other equipment, this Contractor shall include the cost of same in his price.
- D. Dimensions, elevations and relative locations of existing equipment, sewers, pipes, ducts, etc. in place as shown on the Drawings, are taken from record drawings and/or field observation and are deemed reliable only insofar as general layout is concerned. Such dimensions shall not be used for layout drawings nor detailing of components. The responsibility for checking in place items will be the Contractor's. All measurements, the exact determination of relative elevations or locations, the ascertaining of accuracy of all given elevations and dimensions and the obtaining of all necessary additional information to insure the proper fit and coordination of all equipment, ducts, and piping shall be the responsibility of the Contractor.

3.08 WORKMANSHIP AND LAYOUT

- A. All work shall be done by mechanics skilled in the particular trade involved, under responsible supervision, and with the best modern practices.
- B. Contractor shall consult all drawings, construction details and job site and confer and cooperate with other Contractors and the Owner to avoid interferences.
- C. All materials shall be new and of the grade and quality specified. Only the best material of each class specified shall be used.
- D. The General Contractor will provide duct openings and pipe shaft openings in the new construction where shown on the architectural or structural drawings and also where indicated and sized by this Contractor. Openings required due to untimely or inaccurate layout by the Mechanical Contractor shall be at the Mechanical Contractor's own expense using skilled workmen and the proper tools for the work involved.

3.09 CUTTING AND PATCHING

- A. All cutting and patching of, or repair of damage to work in place or in existing construction shall be done in a neat and workmanlike manner, meeting with the approval of the Architect. Mechanical Contractor whose operations require cutting of work in place or existing construction, or who causes damage which entails repairs of such work, shall employ mechanics of the particular trade whose work must be cut or which is damaged, and shall pay all costs of such cutting or repair. All patching required to match existing adjacent construction shall be by the General Contractor at the Mechanical Contractor's expense.
- B. No structural members shall be cut without the approval of the Architect and any such cutting shall be done in a manner directed by the Architect.

3.10 PROTECTION

- A. The Contractor shall provide approved protection for all work included in this Contract and be responsible for damage of any kind to fixtures, piping or other work. At the completion of the project, the Contractor shall remove all protection and replace all damaged work without expense to the Owner.
- B. In addition to the normal precautions for protection of work, Contractor shall provide various types of protection as follows:
 - 1. Protect finished floors from chips and cutting oil by the use of metal chip receiving pan and an oil proof floor cover.
 - 2. Protect equipment and finished surfaces from welding and cutting spatters with baffles and spatter blankets.
 - 3. Protect equipment and finished surfaces from paint droppings, insulation adhesive and sizing droppings, etc. by use of drop cloths.
- C. All pumps, motors, fans and other rotating equipment shall be stored at the site with openings, bearings, etc. covered to exclude dust and moisture. All stock piled pipe shall be placed on dunnage and protected from weather and from entry of foreign material.
- D. During construction, open ends of ducts, pipes, equipment, etc. shall be capped or plugged to reduce dirt accumulation inside.

3.11 MANUFACTURER'S DIRECTIONS

- A. Manufacturer's directions shall be followed in all cases where the manufacturer of articles used in this Contract furnish directions covering specific points for the installation, startup, operation or maintenance of these articles. Directions in conflict with the Drawings or the Specifications shall be referred to the Engineer for clarification.

3.12 RECORD DRAWINGS

- A. Contractor shall keep an accurate record of all deviations from Contract Drawings. The Contractor shall neatly and correctly enter, in colored pencil, any deviations on Drawings affected during the progress of the project and shall keep Drawings available for inspection.
- B. At completion of job and before final acceptance, make any final corrections to Drawings and deliver same to the Engineer.

3.13 GUARDS FOR ROTATING MACHINERY

- A. Furnish and install guards for all exposed belt drives. Guards shall be rigid and readily removable with openings for checking equipment and motor speeds. Guards shall be attached to equipment and not to floor.
- B. Provide guards over exposed drives such as pump couplings.
- C. Guards to comply with latest OSHA Standards.
- D. If guards cover the grease fittings, provide extended grease tubes to permit lubrication of equipment.

3.14 CLEAN-UP

- A. Contractor shall frequently clean up all refuse, rubbish, scrap materials and debris caused by the Contractor's operations to the end that at all times the site shall present a neat, orderly and workmanlike appearance. Crates and cartons in which materials, equipment or fixtures are received shall be removed daily.
- B. If, in the opinion of the Engineer, neatness is not maintained, the Engineer may have the area cleaned as defined in the General Conditions.
- C. Contractor, at the completion of the work, shall remove all surplus material, false work, temporary structures, including foundations thereof and debris of every nature resulting from their operations and put the site in a neat and orderly condition.
- D. In addition to ordinary precautions in keeping ducts, pipes and equipment clean and free of debris during construction, the Contractor shall make provisions for cleaning out ducts and pipes making use of the greatest velocities available. The Contractor shall provide attendance, temporary connections and filters as required.
- E. The exterior of ducts, pipes and equipment shall be cleaned of all dirt and grease, preparatory to insulation or painting.

3.15 TESTING AND ADJUSTMENT

- A. All work installed under this contract shall be tested in the presence of and to the satisfaction of the inspecting authority having jurisdiction and the Engineer.
- B. All piping or equipment not found tight under test shall be reworked or replaced, as directed.
- C. Contractor shall operate all parts of the entire system, make any and all adjustments and repairs, and shall leave the entire work tested and ready for operation by the Owner and/or operation and final testing and balancing by the Testing and Balancing Subcontractor.

- D. If the installed equipment does not meet the specified capacities (gpm, heat output, cooling output, etc.) or if the motor operating current exceeds the nameplate ratings, such equipment shall be corrected by the Contractor.

3.16 SUBMITTALS

- A. Mechanical Shop Drawings, equipment cuts, and schedules shall be submitted to the Engineer for review, in general before starting the work involved and so as to cause no delay in the Contractor's work or that of any other Contractor or Subcontractor. Number of copies as per the General or Supplementary Conditions of the Contract.
- B. All Shop Drawings, equipment cuts and schedules submitted shall bear the stamp of the Contractor, submitting same as evidence that they have been approved by the Contractor. Correction of dimensions, location of various items, encroachments of work of other Contractors or Subcontractors, or variations from the requirements of the Contract Documents shall be made or corrected by the Contractor.
- C. If the Shop Drawings show variations from the requirements of the Contract Documents because of standard shop practice or any other reason, the Contractor shall make specific mention of such variation in a transmittal letter.
- D. Where field measurements are required or necessary, they shall be made, when possible, before preparation of Shop Drawings and noted as such on Shop Drawings.
- E. The review of Shop Drawings, equipment cuts and schedules by the Engineer will be general and shall be understood to mean that the Engineer has no objection to use of materials or processes shown. The Engineer's review shall not relieve the Contractor of responsibility for errors or omissions and deviations from the Contract requirements.
- F. SHOP DRAWINGS SHALL GENERALLY INCLUDE:
 - 1. Construction of the various parts, method of joinery, type of material, grade, quality and thickness of material, alloy of material, profiles of all sections, reinforcement, anchorage, type of finish and grade of finish, etc.
 - 2. Capacities, types of materials and performance charts that are pertinent to the equipment item. Wiring diagrams, control diagrams, schematic diagrams, working and erection dimensions, arrangement and specifications.

G. ELECTRONIC FORMAT:

1. Shop drawings may be submitted in electronic format utilizing PDF files. The submittal shall be organized by specification section and contain all required information within a PDF document for each specification section. The submittal shall be organized as follows:
 - a. Primary zip file contains a PDF of master transmittal cover page indicating the project name, submitting contractor, contact information and a list of all the sections with titles being submitted. This primary file shall also contain each of the individual PDF files for the individual sections being submitted.
 - b. Sub PDF file for each specification section organized as follows:
 - 1) First Page: Cover page indicating the project name, submitting contractor, contact information, space for Engineer's stamp.
 - 2) Page(s) for contractor qualifications and project certifications.
 - 3) Page(s) for Bill of Materials (BOM) list including part numbers, quantities and references to specification section paragraphs for each part.
 - 4) Page(s) for manufacturer's data sheets.
 - 5) Page(s)/Drawing(s) for system diagrams, riser diagrams, block diagrams, etc.
 - 6) Drawing(s) for floor plans showing equipment locations.
- H. See the individual equipment specification sections for any additional submittal requirements.

3.17 LUBRICATION AND PACKING

- A. All rotating and reciprocating equipment requiring lubrication shall be lubricated with the correct grade, type and quality of lubricant before being placed in service.
- B. Each shaft containing a packing gland shall be checked for condition by backing the packing gland off and examining for proper grade, amount and type of packing as recommended by the manufacturer.
- C. Maintain all lubrication gaskets and packing during construction and assure that at the time of acceptance by the Owner, all are in first class operating condition.
- D. All lubrication fittings shall be extended as required for accessibility.

3.19 LOW-EMITTING MATERIALS

- A. Adhesives and sealants applied inside the building (weatherproofing system), shall comply with the following maximum limits for VOC content (in g/L less water) according to South Coast Air Quality Management District Rule #1168.
1. Metal to Metal Adhesives: 30 g/L.
 2. PVC Welding: 510 g/L.
 3. CPVC Welding: 490 g/L.
 4. ABSC Welding: 325 g/L.
 5. Plastic Cement Welding: 250 g/L.
 6. Adhesive Primer for Plastic: 550 g/L.
 7. Other Sealants: 420 g/L.
 8. Other Sealant Primers: 750 g/L.
- B. Paint sealants applied inside the building (weatherproofing system), shall comply with the following maximum limits for VOC content (in g/L less water) according to South Coast Air Quality Management District Rule #1113.
1. Waterproofing Sealers: 250 g/L.

3.20 SLEEVES

- A. Sleeves shall be installed by the Contractor wherever pipes pass through walls, slabs, floors or ceilings. No pipes shall pass through beams or be embedded in concrete. Sleeves in concrete shall be standard weight steel pipe or purchased units as specified below. Twenty-six (26) gauge galvanized steel sleeves are acceptable in wood, plaster or drywall partitions. All sleeves shall be sawed or machine cut (no flame cutting) and flush with finished surfaces except for mechanical equipment areas which shall extend 2 inches above finished floor and be of galvanized steel.
- B. Center pipe in sleeves with spacers.

3.21 CORRELATION OF WORK AND INTERFERENCES

- A. Before installing any work, Contractor shall see that such installation will not interfere with clearances required for the proper finishing of Architectural Work including the finishing of surfaces. In general, all ductwork and pipes in finished areas shall be installed and concealed in walls, furred spaces, pipe chases or above suspended ceilings. If an interference occurs, Contractor shall consult with the Engineer before installing the duct or pipe.
- B. Where work of the various Mechanical Contractors must be installed in confined spaces, the Superintendents of the Mechanical Contractors shall coordinate their work with the Superintendents of other pertinent trades before installation to assure against interferences. Failure to so coordinate such work shall place the

responsibility for making any required changes in any trade upon the Contractor who shall have failed to join in the required cooperative effort, all at the direction of the Engineer.

3.22 HOISTS, RIGGING, SCAFFOLDING AND TRANSPORTATION

- A. Contractor shall provide all required scaffolding, rigging, staging, tackle, hoists and similar devices and equipment necessary for proper installation of his work, shall remove all temporary materials of this nature when no longer required, and shall be responsible for the safe and lawful use thereof.
- B. Contractor shall be responsible for the transportation of all materials and equipment to the job site, adequate protected storage on site, and all costs of same.

3.23 PROVISIONS FOR LATER INSTALLATIONS

- A. Where work cannot be installed as the structure is being erected, Contractor for such work shall provide and arrange for the building-in of boxes, sleeves, inserts, fixtures or devices as necessary to permit installation of the omitted work during later phases of construction. Contractor shall arrange for and lay out any chases, holes or other openings which must be provided in masonry, concrete or other work.
- B. Contractor shall be responsible for becoming informed of the nature and arrangement of the materials and construction to which this Contractor's work attaches, members with, or passes through.

3.24 OPERATING INSTRUCTIONS

- A. Contractor shall provide two (2) flash drives, each containing all operating, servicing, lubrication, etc. information and parts lists for all equipment installed under this Contractor's Contract. Material shall be grouped together by trades, each item marked with a tab, and an index shall be provided. Drives to be submitted for approval at least thirty (30) days before completion of the work.
- B. Flash Drives to Include
 - 1. Step-by-step procedures for start-up and shut-down of each system and piece of equipment.
 - 2. Normal equipment operating characteristics.
 - 3. Performance data, curves, ratings.
 - 4. Wiring diagrams.
 - 5. Manufacturer's descriptive literature.
 - 6. Automatic controls with diagrams and written description of operation.
 - 7. Spare parts and replacement list for each piece of equipment.
 - 8. Name of service agency, installer and suppliers, and their telephone

- numbers.
 - 9. Final reviewed Shop Drawings.
 - 10. Balance report.
 - 11. Certificates of Tests and Approvals.
 - 12. Mechanical identification lists (Section 23 0553).
- C. Each flash drive shall also contain all temperature control diagrams applicable to the equipment.
- D. Contractor shall arrange for technical instruction of the Owner's Maintenance Personnel by qualified instructors for such time as is reasonably required to instruct them in the operation and maintenance of all mechanical systems. Instruction period shall be after all systems are in operation, and have been tested, balanced and adjusted. Contractor shall video all training sessions. Two (2) copies of video shall be included with closeout materials for future reference by the Owner.

3.25 CONNECTIONS

- A. Contractor shall cooperate fully with the Owner in scheduling and making connections into existing service lines so as to cause the least possible inconvenience and shortest delay in service interruption.
- B. Contractor shall include any time and materials necessary for draining, venting, purging and refilling the existing systems to permit connection of the new equipment, piping, etc.
- C. In no case shall the Contractor disrupt any service without the express permission of the Owner and the Engineer.
- D. It may be necessary that some connections and perhaps some of the piping must be done at night or on weekends. Contractor shall bid the work on straight time and clear any premium time charges with the Engineer and/or Owner.

3.26 REMOVALS AND RELOCATIONS

- A. Contractor to perform all removals and relocations of mechanical systems as indicated on the Drawings or in the Specifications.
- B. The Owner has the right to retain all equipment and/or materials removed. Such items will be so marked, removed by the Contractor and stored on the site where directed by the Owner.
- C. All other materials not claimed by the Owner or reused in the new installation shall be removed from the site by the Mechanical Contractor.
- D. Removed material may contain asbestos or lead. Contractor to advise Owner's Representative of any material which he suspects may contain either asbestos or

lead. Any costs involved with necessary testing of installed materials will be the Owner's responsibility. Removal of any materials which prove to contain asbestos or lead will be the Owner's responsibility.

3.27 EXCAVATION AND BACKFILL

- A. The Contractor shall do all excavating and backfilling in connection with this Contractor's work.
- B. Pipe trenches shall be cut to instrument grade, held to minimum width to accomplish the work, cut out for pipe hubs and fittings to obtain a solid bed for all buried work. In the event trenches are cut too deep, they shall be filled with sand to correct elevation and material shall be mechanically tamped to secure the foundation required. In event that unsuitable material for adequate pipe support is encountered, same shall be removed to sufficient depth and backfill installed to secure proper foundation.
- C. No piping shall be laid in water. Contractor shall provide and operate pumping equipment as may be necessary and shore trenches as may be necessary to prevent caving in of the work. Contractor installing the work shall be responsible for any damage to the work of other Contractors as a result of underground work.
- D. Backfill outside of building lines shall be tamped sand to twenty-four inches (24") above pipe as herein before described for interior work. Clean sand or clean earth, approved by Architect, to complete backfill tamped in layers not to exceed six inches (6"). Final six inches (6") of fill to establish grade shall be clean earth. Fill as necessary to allow for settling.
- E. When or if rock is encountered, the tamped sand bed below the pipe shall be a minimum of six inches (6"). Backfill shall be as specified in the above paragraphs. Explosives shall not be used for rock excavation.
- F. Excess excavated materials and debris shall be removed from the site by Contractor making the excavation.
- G. For underground piping exterior to the facility, provide Seton underground warning tapes, buried above the pipe line at approximately 18" to 24" below grade. Tape to be 2" wide, brightly colored, and shall indicate service of buried pipe. For non-metallic pipe, use metallic lined tape.

END OF SECTION 23 0000

SECTION 23 0513 – COMMON MOTOR/ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Single Phase Electric Motors
- B. Three Phase Electric Motors

1.02 RELATED SECTIONS

- A. Section 26 0533 – Raceways
- B. Section 26 2913 – Electrical Control Panels

1.03 REFERENCES

- A. NEMA MG 1 – Motors and Generators; National Electrical Manufacturers Association.
- B. NFPA 70 – National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. Provide data indicating nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

1.05 QUALITY ASSURANCE

- A. Conform to NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 WARRANTY

- A. See Closeout Submittals for additional warranty requirements.

- B. Provide one year manufacturer warranty for motors.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Baldor Electric
- B. Louis Allis
- C. Westinghouse
- D. General Electric
- E. Emerson Electric
- F. Substitutions: See General Requirements

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. The Mechanical Contractor shall furnish all special control items and motors required for the operation of all equipment provided under their sections of the work.
- B. The Electrical Contractor shall furnish all necessary starters and disconnect switches, except on equipment, which is to be provided with starters or disconnect switches as part of the assembly. The Electrical Contractor will furnish all power wiring through starters and disconnect switches to motors.
- C. **Equipment provided with starters shall include phase loss protection as part of the starter package.**
- D. Mechanical Contractor shall provide all power wiring for controls, control and/or interlock wiring required for his particular work. Mechanical Contractor shall also include any wiring required as noted in the individual sections of the Specifications. All wiring required by this Contractor shall be in accordance with provisions as set forth under the National Electric Code and Division 26 Electrical Work of these Specifications.
- E. Where electrical requirements and/or motor horsepowers for the equipment supplied varies from that shown on the Mechanical Drawings or as specifically called out in the Mechanical Specifications, the Electrical Drawings and Specifications shall govern and be adhered to as to electrical power characteristics for the supplied equipment.
- F. Electrical Service:
 - 1. Refer to Drawings

G. Motor Power Requirements:

1. Motors Under 1/2 HP: 115 volts, single phase, 60 Hz.
2. Motors 1/2 HP and Larger: Three phase, 60 Hz, see Drawings for electrical power characteristics.

H. Construction:

1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 40 degrees C environment.
3. Design for temperature rise in accordance with NEMA MG 1-2011 Part 31, definite purpose inverter-fed motors, limits for insulation class, service factor, and motor enclosure type.
4. Motors 5 HP and above that are on variable frequency drives shall have AEGIS shaft grounding rings.

I. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

J. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

K. AIC (AMP-INTERRUPTING CAPACITY) RATING:

1. All equipment operating at 120/1/60 shall have components with a minimum AIC Rating of 10K.
2. All equipment operating at 277/1/60 shall have components with a minimum AIC Rating of 14K.
3. All equipment operating at 208/1/60 or 208/3/60 shall have components with a minimum AIC Rating of the following:
 - a. 208V
0-50A-10kA
51-150A-25kA
151A and greater – 65Ka

4. All equipment operating at 460/1/60 or 460/3/60 shall have components with a minimum AIC Rating of the following:
 - a. 480V
0-100A-18kA
101-399A-35kA
400 and greater 65kA
5. Ratings above shall be based on the MOCPP required. Refer to mechanical equipment schedules for actual rating of each piece of equipment.

PART 3 – EXECUTION

3.01 INSTALLATION

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

END OF SECTION 23 0513

SECTION 23 0519 – GAUGES FOR HVAC PIPING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Pressure Gauges and Pressure Gauges Taps
- B. Thermometers and Thermometer Wells

1.02 RELATED SECTIONS

- A. Section 23 2113 – Hydronic Piping

1.03 REFERENCES

- A. ASME B40.100 – Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers.
- B. ASTM E 1 – Standard Specification for ASTM Thermometers.

1.04 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Project Record Documents: Record actual locations of components and instrumentation.
- D. Operation and Maintenance Data.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 – PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers:
 - 1. H.O. Trerice
 - 2. Weiss Instruments
 - 3. Ashcroft Pressure and Temperature Instruments
 - 4. Winters Instruments

5. Weksler Glass Thermometer Corp.
 6. Marsh Instruments
 7. Miljoco Corporation
 8. Substitutions: See General Requirements
- B. Pressure gauge shall be H.O. Trerice #500X with cast aluminum case, 4-1/2 inches diameter white dial finished with black embossed figures and graduations, adjustable micrometer-type pointer, stainless steel rotary type movement, black bronze bourdon tube, 1/4 inch NPT brass bottom connected socket. The gauge shall have an accuracy of 1/2 percent of the scale range.
- C. Provide shutoff needle valve equal to Trerice 735 or 740 to enable gauge removal without shutting down system. Pet cock will not be acceptable.
- D. On hydraulic system, provide Model 872 snubber to prevent wear on the gauge and reduce shock.

2.02 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi
- B. Needle Valve: Brass, Steel or Stainless Steel 1/4 inch NPT for minimum 150 psi
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:
1. H. O. Trerice
 2. Weiss Instruments
 3. Weksler Glass Thermometer Corp.
 4. Ashcroft Pressure and Temperature Instruments
 5. Winters Instruments
 6. Marsh Instruments
 7. Miljoco Corporation
 8. Substitutions: See General Requirements
- B. Thermometer shall be H.O. Trerice #BX 91403 1/2 adjustable angle industrial thermometer with 9 inch scale, cast aluminum or molded glass reinforced polyester case, Model 3-4F2 size 3-1/2 inches brass separable socket (3/4 inch NPT).
- C. Thermometer shall be installed in a manner that insures that the bulb of the thermometer will be in a flow of fluid and yet not impair the flow of the fluid. Increase pipe size at this point if required.

2.04 TEST PLUGS

A. Manufacturers:

1. Peterson Engineering Co.
2. Suzuki Plugs
3. Flow Design, Inc.
4. Substitutions: See General Requirements

B. Provide test plug, ¼ inch NPT fitting, with cap, to receive either a pressure or temperature probe, 1/8 inch outside diameter. Test plug shall be all brass construction for copper pipes and stainless for ferrous pipes, with a valve core of Nordel, and shall be rated for 400 psig and for service from 45 degrees F to 275 degrees F. Use extra long (XL) model on any piping which is insulated.

C. Contractor shall furnish to the Owner, two pressure gauge adapters, one gauge 0 to 30 inch vacuum, one gauge 0 to 100 psi and two 5 inch stem thermometers, one at 25-125 degrees F and one at 0-220 degrees F.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide one pressure gauge per pump, unless otherwise shown, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

C. Install pressure gauges with pulsation dampers. Provide needle valve to isolate each gauge. Extend nipples and siphons to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

E. Install thermometers in air duct systems on flanges.

F. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

G. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

H. Coil and conceal excess capillary on remote element instruments.

- I. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- J. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- K. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- L. Locate test plugs adjacent thermometers and thermometer sockets, adjacent to pressure gauges and gauge taps, adjacent to control device sockets or where indicated.

END OF SECTION 23 0519

SECTION 23 0523 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Valves:
1. Gate Valves
 2. Globe or Angle Valves
 3. Ball Valves
 4. Plug Valves
 5. Butterfly Valves
 6. Check Valves

1.02 RELATED SECTIONS

- A. Section 23 0553 – Identification for HVAC Piping and Equipment.
- B. Section 23 0719 – HVAC Piping Insulation.
- C. Section 23 2113 – Hydronic Piping.

1.03 REFERENCES

- A. ASME B 31.9 – Building Services Piping; The American Society of Mechanical Engineers; (ANSI/ASME B31.9).

1.04 SYSTEM DESCRIPTION

- A. This Contractor shall furnish all valves as indicated on the Drawings and as required for the proper control at various apparatus so that any apparatus may be removed for repair without interference to the remainder of the building.

1.05 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. Product Data: Include data on valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.06 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 – PRODUCTS

2.01 SCHEDULE OF VALVES – (HVAC)

GENERAL SERVICE	TYPE	MIN. VALVE RATING CWP (PSI) NON SHOCK	ENDS	BODY	TRIM	MANUFACTURER
Heat Pump Loop 2½" and larger (Steel Pipe) (Rated for 250°F)	Gate	450#	Flanged	C.I.	Bronze	Nibco F-617
	Globe	200#	Flanged	C.I.	Bronze	Nibco F-718-B
	Check	200#	Flanged	C.I.	Bronze	Mueller #105M-AP
	Balance	240#	Flanged	C.I.	----	Nibco F-737A
	Butterfly	250#	Tapped	C.I.	EPDM Liner EPDM Liner	Grinnell Series 8000 Victaulic Series 700
	Butterfly (Grooved)	200#	Lug Grooved	C.St. Electro-plated zinc		
Heat Pump Loop[2" and smaller (Steel Pipe) (Rated for 250°F)	Globe	200#	Screwed	Bronze	Bronze	Nibco T-211-B
	Check	200#	Screwed	Bronze	Bronze	Nibco T-413-B
	Balance	240#	Screwed	Brass	Brass	Nibco T-1710
	Ball	600#	Screwed	Bronze	Teflon	Nibco T-585-70
Heat Pump Loop All sizes (Copper Pipe) (Rated for 250°F)	Globe	200#	Screwed	Bronze	Bronze	Nibco T-211-B
	Globe	200#	Soldered	Bronze	Bronze	Nibco T-211-Y
	Check	200#	Screwed	Bronze	Bronze	Nibco T-413-B
	Check	200#	Soldered	Bronze	Bronze	Nibco S-413-B
	Balance	240#	Screwed	Brass	Brass	Nibco T-1710
	Ball	600#	Screwed	Bronze	Teflon	Nibco T-585-70
	Butterfly	200#	Press System	D.I.	EPDM Liner	Nibco PFD2000
	Ball	200#	Press System	Bronze	Teflon	Nibco PCM585-70

2.02 VALVE NOTES

- A. Butterfly valve shall conform to the construction set forth in this schedule and shall be as manufactured by Centerline, Crane, Keystone, Stockham, Milwaukee, Nibco, Watts or Grinnell. Valve shall be full pressure rated to 200 psi on dead end service. Butterfly valve shall have aluminum bronze disc, Ethylene Propylene Diene Monomer (EPDM) liner and be of the tapped lug type. Any valve, 6 inches and under, shall have trigger lock manual operator (unless modified in Paragraph B) and any valve, 8 inches and over, shall have gear operated valve wheel.
- B. Any butterfly valve over 7 feet - 6 inches above the floor in mechanical equipment rooms, boiler rooms, and the like, shall have gear operated valve wheel.
- C. Ball valve shall conform to the construction set forth in this schedule and shall be as manufactured by Nibco, Milwaukee, Smith, Crane, Apollo or Watts, Soldered joint ball valves in copper piping are not acceptable. Ball valve in insulated pipe line shall have 2 inch extension stem with handle.
- D. Check valve in hydronic piping 2½ inches and larger shall be Mueller Silent Globe Check No. 105M-AP (200 lb) [No. 107M-AP (250 lb.)]. Valve shall have cast iron body, bronze disc, and stainless steel trim. Equivalent valve by Metraflex, SSI or GEM is acceptable. Provide at least six pipe diameters or a minimum of 24 inches, whichever is greater, between pump outlet and the check valve.
- E. Other Valves – Gate, Globe, Balance and Check – Shall conform to the construction as set forth in this schedule and shall be as manufactured by Crane, Milwaukee, Nibco, Resun, or Nordstrom lubricated plug valves are acceptable.
- F. If a grooved pipe system is used, the following applies:
 - 1. Butterfly valve shall conform to construction set forth previously and shall be as manufactured by Victaulic or approved equal. Grooved system butterfly valve shall be designed for bubble tight shutoff to 200 psi and liner supplied for water services from -30 degree F to +200 degree F, Grade “E” EPDM with aluminum, bronze or chrome plated ductile iron disc.
 - 2. Ball valve shall conform to the construction set froth in this schedule and shall be as manufactured by Victaulic or approved equal, be designed for 600 psi with body end cap ASTM A-536 with Endurion coating the TFE seals.
 - 3. Check valve shall be Mueller as indicated in Paragraph D above. Grooved check valves are not acceptable.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Prepare valve connection to piping with flanges or unions.
- B. Remove scale and dirt on inside and outside of valves prior to assembly.

3.02 INSTALLATION

- A. Install valves in accordance with manufacturer's instructions.
- B. Where a water flow balancing valve is required in pipes up to 2 inches, a ball valve may be used. Valve to meet the above schedule, have handle removed after system is balanced, and shall not be used for shutoff purposes. (Separate individual valves required for balancing and for shutoff purposes.) Handles shall be given to the Owner.
- C. Any valve (butterfly, gate, globe, ball) requiring chain operator shall be indicated on the Drawings.
- D. Valves to be installed in an accessible location that allows for proper operation of the valve handle.
- E. Any valves installed in concealed spaces to have a proper access door for valve operation and maintenance.
- F. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

END OF SECTION 23 0523

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

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Hangers and Supports For:
 - 1. HVAC Piping System
 - 2. HVAC Equipment

1.02 RELATED SECTIONS

- A. Section 23 2113 – Hydronic Piping
- B. Section 23 2114 – Hydronic Specialties

1.03 REFERENCES

- A. ASME B31.9 – Building Services Piping; The American Society of Mechanical Engineers; (ANSI/ASME B31.9).

1.04 SYSTEM DESCRIPTION

- A. Contractor shall furnish and install all adjustable hangers, special pipe supports, spring hangers, anchors, clamps, rods, and appurtenances as required to securely and properly hang or support the piping systems. Hangers and supports shall be equivalent to the Anvil models specified.
- B. Contractor shall provide all miscellaneous steel and hardware as required to support, hang and secure all equipment, ducts, pipes, etc. as furnished by him, unless such materials are specifically called out to be provided by other Contractors.

1.05 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. Product Data: Include data on hangers and accessories. Provide manufacturers catalogue information. Indicate data and ratings.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods.

1.06 QUALITY ASSURANCE

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

- B. Welders: Certify in accordance with ASME (BPV IX).

1.07 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Accept hanger material on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide proper storage.

1.09 EXTRA MATERIALS

- A. See General Requirements for additional provisions.

PART 2 – PRODUCTS

2.01 HANGERS

- A. Hangers not otherwise noted or specified shall be adjustable wrought iron clevis type, Anvil No. 260, for insulated and non-insulated steel pipe and insulated copper tubing. Bare copper tubing shall be supported with copper-plated plastic-coated hangers, Anvil Fig. CT-69. Suitable trapeze type hangers may be used where several lines are running parallel.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. All piping systems shall have anchorage, sway braces, guides and supports satisfactory to the Architect and shall be fabricated in accordance with ANSI Code B31.9, "Building Services Piping", latest issue, and must be installed with due regard for general requirements.
- B. Where hangers are supported from the building structural steel, they shall be attached to structural members by beam clamps bearing on both sides. Do not weld hanger rods to structural steel. When attaching to bar joists, attach at the panel points only. Attach to concrete decking using expansion bolts or concrete anchors. Anchors in overhead concrete deck and precast concrete panels shall meet ICC-ES AC193 (mechanical anchors) for both cracked and un-cracked concrete.

- C. At all hangers and supports of insulated pipe, provide oversized hangers to fit on the outside of the pipe saddles and shields. See insulation specification section for insulation thickness.
- D. For all insulated piping over 4 inch, Insulation Subcontractor to provide special supporting insulation and shield. Hanger or support to be external to insulation and shield.
- E. For all insulated piping 4 inch and under, provide hangers on outside of insulated pipe (all sizes) with shields.
- F. Ductwork, piping, etc. shall be independently supported from the building structure and shall not be supported from other ducts, pipes, etc. Where interferences do occur, provide trapeze type hangers or supports.

3.02 SCHEDULES

- A. Piping shall be supported with hangers spaced in accordance with the following schedules. Each section of pipe shall have at least one (1) hanger. Vertical lines shall be supported by pipe clamp type supports designed for this purpose at each floor level. On plastic piping which is insulated, reduce spacing to 70 percent of distances listed.

<u>(1) Steel Pipe</u>		<u>(2) Copper Tubing</u>		<u>(3) Rigid PVC Pipe (Up to 140°F)</u>	
<u>Pipe Size</u>	<u>Maximum Spacing</u>	<u>Pipe Size</u>	<u>Maximum Spacing</u>	<u>Pipe Size</u>	<u>Maximum Spacing</u>
Thru 1-1/4"	7'	Thru 3/4"	5'	Thru 1-1/4"	2-1/2'
1-1/2"	9'	1"	6'	1-1/2" & 2"	3'
2"	10'	1-1/4"	7'	2-1/2"	3-1/2'
2-1/2"	11'	1-1/2"	8'	3"	3-1/2'
3"	12'	2"	8'	4"	3-1/2'
4"	14'	2-1/2"	9'	6"	4'
6"	17'	3"	10'	8"	4'
		4"	12'		

- B. Hanger and Rod Size Shall be as Follows:

<u>Pipe Size</u>	<u>Rod Size</u>
3/4 to 2 inch inclusive	3/8"
2-1/2 to 3-1/2 inch inclusive	1/2"
4 and 5 inch	5/8"
6 inch	3/4"
8 to 12 inch inclusive	7/8"

C. Duct Hangers and Supports

1. Hangers for ductwork shall be in accordance with latest SMACNA Standards, "Hangers for Ducts and Upper Attachments". All hanger strap material shall be galvanized. Ductwork shall be supported from the overhead construction using concrete inserts or anchors attached to the concrete. With structural steel and bar joist construction, use welded studs or C-clamps with retaining clip attached to the steel. In all cases, the maximum hanger spacing shall not be exceeded and the hangers shall be readily removable.

END OF SECTION 23 0529

SECTION 23 0548 – VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Vibration Isolators

1.02 RELATED SECTIONS

- A. Section 23 2123 – Pumps

1.03 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. Product Data: Provide schedule of vibration isolator type with location and load on each.
- C. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate seismic control measures.
- D. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Korfund Technology, Inc.
- B. Kinetics Noise Control, Inc.
- C. Mason Industries
- D. Vibration Eliminator Company
- E. Substitutions: See General Requirements

2.02 VIBRATION ISOLATORS

- A. Open Spring Isolators:
 - 1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.

2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

B. Restrained Open Spring Isolators:

1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
4. Restraint: Provide heavy mounting frame and limit stops.
5. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

C. Closed Spring Isolators:

1. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

D. Restrained Closed Spring Isolators:

1. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

- E. Spring Hanger:
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 2. Housings: Incorporate rubber hanger with treaded insert or neoprene isolation pad meeting requirements for neoprene pad isolators.
 3. Misalignment: Capable of 20 degree hanger rod misalignment.
 4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
- F. Neoprene Pad Isolators:
1. Rubber or Neoprene Waffle Pads:
 - a. Hardness: 30 Durometer
 - b. Thickness: Minimum 1/2 inch
 - c. Maximum Loading: 50 psi
 - d. Rib Height: Maximum 0.7 times width
 2. Configuration: Single Layer
 - a. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Furnish and install vibration isolation for all mechanical equipment as scheduled below.
- B. Vibration isolation equipment shall be furnished to reduce transmission of vibration between rotating mechanical equipment and the building structure, an isolation efficiency of 90 percent or more to be provided in all cases. Isolator shall be protected from moisture, oil or surrounding damaging materials by an approved method of sealing the material.
- C. Isolator and supporting base shall be supplied by a single manufacturer. The isolation equipment shall be selected taking into account equipment weight, loading, rotating speeds and size of equipment.
- D. Install in accordance with manufacturer's instructions.
- E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary

shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

- G. Support piping connections to equipment mounted on isolators using isolators or resilient hangers for schedule distance or to nearest flexible pipe connector or as follows:
1. Up to 4 Inches Pipe Size: First three points of support
 2. 5 to 8 Inches Pipe Size: First four points of support
 3. 10 inches Pipe Size and Over: First six points of support
 4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.02 FIELD QUALITY CONTROL

- A. Inspect isolated equipment after installation and submit report. Include static deflections.

3.03 SCHEDULE

Equipment Type	Base Type	Isolator Type	Minimum Static Deflection*
In-line Pump	4	2H	1"
Piping in Mechanical Equipment Room	4	2H	1"

* Verify floor span and RPM.

- A. Type 2H:
1. Combination spring and neoprene hangers incorporating ¼ inch thick ribbed neoprene noise isolation pad in series with springs. Unit shall be Kinetics Model SRH.
- B. Type 4:
1. No base required, isolator attached directly to machine.

END OF SECTION 23 0548

SECTION 23 0553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Nameplates
- B. Tags
- C. Stencils
- D. Pipe Markers

1.02 REFERENCES

- A. ASME A13.1 – Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers.

1.03 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Brady Corporation
- B. Champion America, Inc.
- C. Seton Identification Products
- D. Substitutions: See General Requirements

2.02 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters
1. Letter Color: White or Black
 2. Letter Height: 1/2 inch
 3. Background Color: Black, Red, Green or Yellow

2.03 VALVE TAGS

- A. Contractor shall provide a numbered brass tag, approximately 2 inches in diameter, chained to hand wheel of each valve, except local stop or shutoff valves to an item of equipment. Attach tag to valve with non-rusting "S" hook of adequate size. Each tag shall be stamped with a serial number and service designation of valve. Also indicate on tag whether the valve is normally-closed or normally-open in service (N.C. or N.O.).
- B. Numbers and locations shall be accurately marked on the "Record Drawings".
- C. Provide typed valve directions identifying each valve as to size, manufacturer, type, service and location. Copies shall be included in the Operating Instruction and Service Manual hereinafter specified.
- D. Verify numbering and tag designation system with Owner in order to be consistent with any existing identification system.
- E. Where applicable, after the above symbols, add "S" for supply and "R" for return piping.

2.04 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
1. 3/4 to 1-1/4 Inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters
 2. 1-1/2 to 2 Inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters
 3. 2-1/2 to 6 Inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters
 4. 8 to 10 Inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters
 5. Over 10 Inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters
 6. Ductwork and Equipment: 2-1/2 inch high letters
- B. Include size of pipe on stencil.

- C. Stencil Paint: Semi-gloss enamel, colors conforming to ASME A13.1.
- D. Provide one (1) coat of clear lacquer, polyurethane or varnish over the stencils.

2.05 PIPE MARKERS

- A. Color: Conform to ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow, size of pipe and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with paint manufacturer's recommendations for stencil painting.

3.02 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with paint manufacturer's recommendations.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

- G. Identify air handling units, fans, pumps, heat transfer equipment, tanks, and water treatment devices with stencil painting or plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- H. Identify control panels and major control components outside panels with plastic nameplates.
- I. Identify thermostats relating to terminal boxes or valves with nameplates.
- J. Identify valves in main and branch piping with tags.
- K. Identify air terminal units and radiator valves with numbered tags.
- L. Tag automatic controls, instruments, and relays. Key to control schematic.
- M. Each pipe exposed or in an accessible space shall be identified as to size, service and direction of flow by stenciling with 1 inch high characters at each major change of direction, at 20 foot intervals in long straight runs, each branch connection, each riser, equipment connection, and both sides of a wall through which pipe passes. In architecturally finished areas, at the Architect's option, stenciling may be omitted.
- N. Identify ductwork with stencil painting or plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- O. Manufactured labels are acceptable, providing they are properly attached to clean and dust-free surface to prevent curling or loosening.
- P. Verify nomenclature with Owner in order to be consistent with any existing identification system.

END OF SECTION 23 0553

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

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Testing, Adjustment, and Balancing of Hydronic Systems
- B. Measurement of Final Operating Condition of HVAC Systems

1.02 REFERENCES

- A. AABC MN-1 – AABC National Standards for Total System Balance; Associated Air Balance Council.
- B. ASHRAE Std 111 – Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
- C. NEBB (TAB) – Procedural Standards for Testing Adjusting Balancing of Environmental Systems; National Environmental Balancing Bureau.

1.03 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. Qualifications: The agency selected shall be a fully certified member of the National Environmental Balancing Bureau or Associated Air Balance Council (ABC), or an independent firm whose principals are registered Professional Engineers.
- C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Submit to the Commissioning Authority or Owner Representative within two weeks after completion of testing, adjusting, and balancing.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone Number of Testing, Adjusting, and Balancing Agency

- d. Project Name
- e. Project Location
- f. Project Architect
- g. Project Engineer
- h. Project Contractor
- i. Project Altitude
- j. Report Date

- D. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

1.05 QUALITY ASSURANCE

- A. All work shall be done with the best modern practices and equipment.
- B. All instruments used for measurement shall be accurate, and calibration for each instrument shall be available for examination. The Architect has the right to request instrument recalibration, or the use of other instruments, where accuracy of readings is questionable.
- C. Perform Work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, or registered Professional Engineer experienced in performance of this Work and licensed at the State in which the Project is located.

PART 2 – EXECUTION

2.01 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Fans are rotating correctly.
 - 5. Air coil fins are cleaned and combed.
 - 6. Hydronic systems are flushed, filled, and vented.
 - 7. Pumps are rotating correctly.
 - 8. Proper strainer baskets are clean and in place.
 - 9. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- C. Beginning of work means acceptance of existing conditions.

- D. The Balancing Subcontractor shall consult all drawings, construction details, job site and confer and cooperate with other Contractors to avoid interference.
- E. The Balancing Subcontractor shall check all control interlocks and cooperate with the Control Contractor in adjusting and calibration of control equipment.
- F. The Balancing Subcontractor shall deliver to the Engineer in writing, all comments regarding the systems and any and all deficiencies found during the balancing of the systems. Preferably this should be done before the final system balance to allow any corrective procedures to take place.

2.02 MISCELLANEOUS TESTS

- A. Record instrument tests to confirm performance of water systems.
- B. All electrical interlocking shall be tested and verified. This work shall be accomplished with a representative of the Heating, Ventilating and Air Conditioning Contractor and Control Contractor present and assisting.

2.03 FINAL OBSERVATION AND ACCEPTANCE

- A. At the time of the final observation and, if requested, the Balancing Contractor shall recheck, in the presence of the Engineer, random selections of data (water and air quantities, air motion), recorded in the certified report. Points or areas for recheck shall be selected by the Engineer.
- B. A measured flow deviation of plus or minus 5 percent or more from the certified report listing, at 10 percent or more of the selected recheck stations, shall automatically result in the rejection of the report. In the event the report is rejected, all systems shall be re-balanced and new certified reports submitted and another observation made at no additional cost to the Owner.
- C. Following final acceptance of certified report by the Engineer, the settings of all valves, splitters, dampers and other adjustment devices shall be permanently marked so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after final acceptance.

2.04 INSTRUCTIONS

- A. The Mechanical Contractor shall coordinate with the Test and Balance Contractor the necessary information, data, etc., in order to adequately instruct the Owner's representative in the proper operation and routine maintenance of the mechanical systems. The instruction sessions shall be for a period of two (2) working days (minimum).

2.05 PREPARATION

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

2.06 INSTALLATION TOLERANCES

- A. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

2.07 RECORDING AND ADJUSTING

- A. Field Logs: Maintain Written Logs Including:
 - 1. Running log of events and issues
 - 2. Discrepancies, deficient or uncompleted work by others
 - 3. Contract interpretation requests
 - 4. Lists of completed tests
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- F. TAB Verification: Project Manager shall randomly select measurements documents in the final report to be rechecked. The rechecking shall be limited to 5% of the total measurements recorded or what can be measured in (1) eight hour period.
- G. Seasonal Testing: If initial TAB procedures were not performed during near peak summer and winter conditions, perform additional testing, inspection and adjusting during near peak summer or winter conditions.

2.09 WATER SYSTEM PROCEDURE

- A. Prior to final inspection of the building or project, all heating and cooling water systems shall be adjusted as necessary to provide required or design quantities or each component.

- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- F. Where available pump capacity (as designed) is less than total flow requirements of individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

2.10 SCOPE

- A. Test, Adjust, and Balance the following:
 - 1. HVAC Pumps
 - 2. Cooling Tower (Pumps and Fans)

2.11 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer
 - 2. Model/Frame
 - 3. HP/BHP
 - 4. Phase, Voltage, Amperage; Nameplate, Actual, No Load
 - 5. RPM
 - 6. Service Factor
 - 7. Starter Size, Rating, Heater Elements
 - 8. Sheave Make/Size/Bore
- B. V-Belt Drives:
 - 1. Identification/Location
 - 2. Required Driven RPM
 - 3. Driven Sheave, Diameter and RPM
 - 4. Belt, Size and Quantity
 - 5. Motor Sheave Diameter and RPM

C. Pumps:

1. Identification/Number
2. Manufacturer
3. Size/Model
4. Impeller
5. Service
6. Design Flow Rate, Pressure Drop, BHP, RPM
7. Actual Flow Rate, Pressure Drop, BHP, RPM
8. Discharge Pressure
9. Suction Pressure
10. Total Operating Head Pressure
11. Shut Off, Discharge and Suction Pressures
12. Shut Off, Total Head Pressure

G. Air Moving Equipment:

1. Location
2. Manufacturer
3. Model Number
4. Serial Number
5. Arrangement/Class/Discharge
6. Air Flow, Specified and Actual
7. Return Air Flow, Specified and Actual
8. Outside Air Flow, Specified and Actual
9. Total Static Pressure (Total External), Specified and Actual
10. Inlet Pressure
11. Discharge Pressure
12. Fan RPM
13. Supply Air Temperature Dry Bulb/Wet Bulb

J. Flow Measuring Stations:

1. Identification/Number
2. Location
3. Size
4. Manufacturer
5. Model Number
6. Serial Number
7. Design Flow Rate
8. Design Pressure Drop
9. Actual/Final Pressure Drop
10. Actual/Final Flow Rate
11. Station Calibrated Setting

END OF SECTION 23 0593

SECTION 23 0719 – HVAC PIPING INSULATION

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Pipe Insulation, Jacketing and Accessories

1.02 RELATED SECTIONS

- A. Section 23 0000 – Basic Heating, Ventilation & Air Conditioning (HVAC) Requirements

1.03 REFERENCES

- A. ASHRAE Std 90.1 – Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings; 2001.

1.04 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. See Section 23 0000 for low VOC submittal requirements.
- C. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation Instructions and Recommendations
 - 2. Installation Methods

PART 2 – PRODUCTS

2.01 MANUFACTURES

- A. Manufacturers:
 - 1. Knauf Fiber Glass
 - 2. Johns Manville International, Inc.
 - 3. Owens Corning Corp.
 - 4. Armstrong Corp.
 - 5. Certainteed Corp.
 - 6. Aerocel
 - 7. Armacell
 - 8. K-Flex
 - 9. Substitutions: See General Requirements

2.02 PIPE INSULATION

- A. All insulation, unless otherwise noted, shall have a composite rating including insulation adhesives, jacket, etc. as follows. The composite assembly shall have a flame spread rating not over 25 and a smoke developed rating not higher than 50.
- B. The water piping insulation material shall be a UL-rated, noncombustible pipe insulation recommended for both hot and cold piping. Insulation shall be a heavy density sectional pipe insulation jacketed with an embossed vapor barrier laminated all-service jacket with self-sealing lap adhesive. Lap and seal all joints to insure vapor barrier. Thermal conductivity (k) shall not exceed 0.24 BTUH square foot F degree/inch. Insulation shall equal Owens-Corning Fiberglas 25 ASJ/SSL. Thickness as per tables in other sections of these Specifications. If staples are used on cold water lines, apply white vapor barrier mastic over staples.
- C. Where fiberglass insulation on piping is used, pipe fittings shall be covered with insulating cement of a thickness equal to adjacent pipe insulation and wrapped with glass cloth.
- F. In lieu of building up a fitting with insulating cement, a preformed insulating fitting cover such as Zeston 25/50 rated PVC insulated fitting cover with fiberglass insert may be used.
- G. Only insulating materials meeting the 25/50 flame spread and smoke developed ratings are allowable in air ducts, air chases or air plenums.
- H. Any exposed insulated piping passing through a floor where it is subject to damage, shall be covered with a 0.016 inch (minimum) thick aluminum jacket 18 inches high.
- I. Insulate piping exposed to the weather with insulation as specified earlier except add one inch (1") additional thickness. Cover with a .016" thick smooth aluminum jacket with two inch (2") overlap at longitudinal and circumferential joints and secured in place with 1/2" x .020" stainless steel banding on eighteen inch (18") centers.

2.03 DAMAGED INSULATION

- A. All insulation damaged or removed due to work under this Contract shall be replaced with new insulation according to above specifications.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and applicable building codes.

- B. Locate seams in least visible location. Extend surface finishes to protect raw edges, ends and surfaces of insulation.
- C. Where vapor retarder facing or jacketing is specified, maintain continuous, unbroken moisture and vapor seal; insulate and vapor seal all hangers, supports, anchors, and other projections secured to cold surfaces to prevent condensation; repair penetrations and damage to vapor retarder using joint tape prior to system startup.
- D. Install pipe insulation continuously through walls, ceiling and floor openings, and sleeves except where firestopping materials are required.
- E. Insulation installed on piping operating below ambient temperature must have a continuous vapor retarder. Seal all joints, seams and fittings.
- F. Inserts and Shields:
 - 1. Furnish and install at all hangers and supports of insulated pipe, 12" long sections of high density insulation that will not deflect more than 1/8" in an operating condition and covering at least 120 degree of the arc at the bottom of the pipe. On horizontal lines, provide 22 gauge galvanized sheet metal shields covering 50 percent of the circumference. On vertical lines, the sheet metal shields shall completely encircle the insulation. Maintain a full vapor barrier around the insulation as it passes through the shield. Pipe hanger, roller, or support shall be external at the shield. Contractor shall butt the adjacent insulation tightly to the insulation at the pipe shields and lap and seal all seams and joints. Special care shall be taken to insure that the vapor barrier at the pipe shields is not broken. Wood spacer between pipe and hanger is not allowed.
 - 2. Insert Location: Between support shield and piping and under the finish jacket.
 - 3. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 4. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

3.02 SCHEDULES

A. Heat pump Loop Piping:

	<u>Pipe Sizes</u>					
	<u>As Noted</u>	<u>Runouts*</u>	<u>Below 1½"</u>	<u>1½"-3"</u>	<u>4"-8"</u>	<u>Above 8"</u>
Heat Pump Loop Piping	----	1-1/2	1-1/2	2	2	2

END OF SECTION 23 0719

SECTION 23 0913 – INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Thermostats
- B. Miscellaneous Accessories

1.02 RELATED SECTIONS

- A. Section 23 0519 – Gauges and Meters
- B. Section 23 2113 – Hydronic Piping: Installation of Control Valves, Flow Switches, Temperature Sensor Sockets, Gauge Taps
- C. Section 23 0993 – HVAC Sequence of Operation

1.03 REFERENCES

- A. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.
- B. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilation Systems; National Fire Protection Association.

1.04 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Manufacturer's Instructions: Provide for all manufactured components.
- E. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.

- F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- G. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

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

1.06 WARRANTY

- A. See Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a one year period after Substantial Completion.

1.07 MAINTENANCE SERVICE

- A. Provide service and maintenance of control system for one year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Johnson Controls
- B. Or Equal

2.02 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.

2.03 INPUT/OUTPUT SENSORS

A. Temperature Sensors:

1. Resistance temperature detectors with resistance tolerance of plus or minus 0.1 percent at 70 degrees F, interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.
2. Measuring current maximum 5 mA with maximum self-heat of 0.031 degrees F/mW in fluids and 0.014 degrees F/mW in air.
3. Provide 3 lead wires and shield for input bridge circuit.
4. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification sensor length 8 feet or 16 feet as required.
5. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2 inches.
6. Room Sensors: Locking cover matching the thermostats used.
7. Outside Air Sensors: Watertight inlet fitting, shielded from direct rays of sun.

B. Equipment Operation Sensors:

1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

2.04 THERMOSTATS

A. Outdoor Reset Thermostat:

1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
2. Scale Range: -10 to 70 degrees F

B. Immersion Thermostat:

1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.

2.05 TRANSMITTERS

A. Pressure Transmitters:

1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic or pneumatic output.

B. Temperature Transmitters:

1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degree F span and plus or minus 1 percent for 50 degree F span, with 50 degrees F, 100 degrees F or 200 degrees F temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.

C. Humidity Transmitters:

1. One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Install top of thermostats etc., 48 inches above floor. Align with lighting switches and humidistats. Refer to Section 26 2726.
- C. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- D. Provide valves with position indicators and with pilot positioners where sequenced with other controls.

- E. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- F. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- G. Provide conduit and electrical wiring in accordance with Section 26 0533 Raceways.

END OF SECTION 23 0913

SECTION 23 0916 – VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Variable Speed Motor Controllers

1.02 RELATED SECTIONS

- A. Section 23 0500 – Common Work Results for HVAC
- B. Section 23 0513 – Common Motor/Electrical Requirements for HVAC Equipment
- C. Section 23 0547 – HVAC Vibration Control
- D. Section 23 0923 – Direct Digital Control Systems

1.03 SUBMITTALS

- A. See General Requirements for submittal procedure.
- B. Product Data: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials.
- C. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- D. Manufacturer's Instructions: Include installation instructions.

PART 2 – PRODUCTS

2.01 VARIABLE SPEED MOTOR CONTROLLERS

- A. Manufacturers:
 - 1. ABB
 - 2. Danfoss
 - 3. Eaton
 - 4. Yaskawa Electric America, Inc.
 - 5. Toshiba
 - 6. Siemens
 - 7. Schneider Electric
 - 8. GE
 - 9. Emerson Electric
 - 10. Substitutions: See General Requirements

- B. Provide a variable frequency drive as part of the Cooling tower, installed and wired at the factory.
- C. Drive shall be housed in NEMA 1 cabinet with necessary provisions for ventilation and cooling. Drive shall have a cabinet operating temperature range of 32°F to 104°F.
- D. Drive shall be completely wired at the factory and ready for connection of power line in and out wiring. Wiring from drive to motor shall be the responsibility of the Electrical Contractor. Drive shall include full factory testing of all components, and shall be factory run before shipping.
- E. Drive shall have sufficient capacity for use on any standard NEMA Design B induction motor at designated motor horsepower.
- F. The inverter shall incorporate a switching power supply operating off the DC link of the controller, eliminating control transformer and line disturbance sensitivity.
- G. The drive shall employ a diode bridge rectifier input providing a constant displacement power factor of 0.98 at all operating speeds and loads.
- H. Drive shall be supplied with an input fused disconnect switch or circuit breaker in the power lines to the controller. Motor overload protection shall be provided for VFD operating and bypass operation. The drive shall perform the function of a motor starter.
- I. Provide a manual bypass to line switch to allow constant speed operation. A separate motor contactor and/or starter shall be provided. Bypass section shall be housed in a separate enclosure attached to the main drive. A three contactor bypass switch shall allow safe servicing of the variable speed controller while the motor is operating in the bypass mode.
- J. The controller shall include an interface board for the connection of external safety devices. External protection devices such as freezestats, pressure stats, smoke detectors, etc. shall function in either the VFD or bypass mode of operation.
- K. Drive shall include a built-in LED diagnostic display to annunciate the following drive protection circuits:
 - 1. Ground Fault
 - 2. Over Current
 - 3. Over Voltage
 - 4. Under Voltage
 - 5. Over Temperature
 - 6. Motor Overload Trip
 - 7. Phase Loss Protection
- M. A fault contact for remote monitoring shall be activated on a protection circuit trip.

- N. Upon trip of any of the preceding conditions, the drive shall attempt an auto restart. Upon five unsuccessful attempts, the drive shall shut down requiring a manual restart.
- O. If a complete loss of power to the drive occurs from a sustained power outage, the drive shall restart automatically and resume proper operation on a return to normal power condition.
- P. Drive shall be capable of being run without the motor attached to facilitate startup and troubleshooting.
- Q. Drive shall be capable of handling fluctuations in input voltage ranging +10%/-15%.
- R. Drive shall include:
 - 1. Adjustable acceleration and deceleration ramps from one to thirty seconds minimum.
 - 2. Maximum and minimum speed adjustment control.
 - 3. Hand-off-auto selector switch.
- S. Provide BACnet certified integration module for drive to seamlessly integrate to the DDC control system specified in Section 23 0923. All enable and speed commands shall be through BACnet integration.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. On HVAC pumps and fans not part of an air handling unit or rooftop unit, variable frequency drives shall be furnished by the HVAC Contractor and installed and wired by the Electrical Contractor.
- B. On cooling tower, variable frequency drives shall be furnished, installed and wired by the equipment supplier or by the HVAC Contractor.
- C. Variable frequency drives shall be checked out and put in operation by the manufacturer's authorized representative. Local supplier shall have complete parts stock and 24 hour emergency service capability.
- D. VFD shall be located as close to the motor as possible. If location of variable frequency drive causes load conductors between the variable frequency drive and motor to exceed manufacturer's recommended maximum length then EMI filters shall be provided at the output of the VFD for reduction of harmonic distortion.

- E. Contractor shall coordinate VFD with proper inverter duty motor. Refer to Specification Section 23 0513 – Common Motor/Electrical Requirements for HVAC Equipment for inverter duty motor specification.

END OF SECTION 23 0916

SECTION 23 0923 – DIRECT DIGITAL CONTROL SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Control Equipment
- B. Software

1.02 RELATED SECTIONS

- A. Section 23 0913 – Instruments and Control Elements
- B. Section 23 0993 – HVAC Sequence of Operation

1.03 REFERENCES

- A. NFPA 70 – National Electrical Code; National Fire Protection Association; 2002.

1.04 SYSTEM DESCRIPTION

- A. Connection into existing Johnson Controls control system with following scope of work:
 - 1. Replace existing cooling tower controller with new BACnet controller.
 - 2. Extend BACnet communication bus into mechanical room to new controller.
 - 3. Provide and install new BACnet controller on new cooling tower.
 - 4. Update graphics to represent new equipment.
 - 5. Run wiring and cabling as required, utilize existing conduits where possible.
 - 6. Pumps to be controlled out of new BACnet controller in mechanical room.

1.05 SUBMITTALS

- A. Product Data: Provide data for each system component and software module.
- B. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. List connected data points, including connected control unit and input device.
 - 3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration diskette containing graphics.
 - 4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

5. Indicate description and sequence of operation of operating, user, and application software.
- C. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- D. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 1. Revise shop drawings to reflect actual installation and operating sequences.
 2. Include submittals data in final "Record Documents" form.
- E. Operation and Maintenance Data:
 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 WARRANTY

- A. Correct defective work within a one year period after substantial completion.

1.08 MAINTENANCE SERVICE

- A. Provide service and maintenance of energy management and control systems for one year from date of substantial completion.
- B. Provide two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

1.09 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications
2. Limiting copying
3. Preserving confidentiality
4. Prohibiting transfer to a third party

PART 2 – PRODUCTS

2.01 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices and wiring is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 0993.
- C. Provide with 120V AC, 15 amp dedicated emergency power circuit to each programmable control unit.
- D. Provide conduit and electrical wiring. Electrical materials and installation in accordance with appropriate requirements of Division 26.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.
- C. Provide basic operator training for 2 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.04 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Owner.

END OF SECTION 23 0923

SECTION 23 0993 – SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Sequence of Operation for:
 - 1. Cooling Tower
 - 2. Pumps

1.02 RELATED SECTIONS

- A. Section 23 0923 – Direct Digital Control System for HVAC
- B. Section 23 0913 – Instrumentation and Control Devices for HVAC
- C. Section 26 0533 – Raceways

1.03 SYSTEM DESCRIPTION

- A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.04 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
 - 1. Label with settings, adjustable range of control and limits.
 - 2. Include written description of control sequence.
 - 3. Include flow diagrams for each control system, graphically depicting control logic.
 - 4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
- C. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

PART 2 – PRODUCTS NOT USED

PART 3 – EXECUTION

3.01 COOLING TOWER, BOILER AND PUMPS

- A. Loop circulating pumps P-1 and P-2 shall be controlled per the existing sequence of operation in the Johnson Metasys system.
- B. On a call for cooling in the heat pump loop, the following shall occur:
 - 1. When loop temperature reaches 80°F (adjustable) open normally closed damper on the cooling tower.
 - 2. When loop temperature reaches 83 °F (adjustable) the cooling tower spray pump shall be started. VFD on cooling tower fan will be modulated to maintain 85 °F (adjustable) loop temperature.
- C. On a call for heat pump loop heating, the following shall occur:
 - 1. When loop temperature falls below 80°F (adjustable) the cooling tower fans & spray pump shall be off & the damper is to be in the closed position.
 - 2. The existing sequence for the heating thru the boilers shall be maintained.

END OF SECTION 23 0993

SECTION 23 2113 – HYDRONIC PIPING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Pipe and Pipe Fittings for:
 - 1. Heating Water Piping System
 - 2. Equipment Drains and Overflows

1.02 RELATED SECTIONS

- A. Section 23 0000 – Basic Heating, Ventilation & Air Conditioning (HVAC) Requirements
- B. Section 23 0516 – Expansion Fittings & Loops HVAC Piping
- C. Section 23 0529 – Hangers and Supports for HVAC Piping and Equipment
- D. Section 23 0548 – Vibration and Seismic Controls for HVAC Piping and Equipment
- E. Section 23 0553 – Identification for HVAC Piping and Equipment
- F. Section 23 0719 – HVAC Piping Insulation
- G. Section 23 2114 – Hydronic Specialties
- H. Section 23 2500 – HVAC Water Treatment: Pipe cleaning
- I. Section 23 2513 – Water Treatment for Closed-Loop Hydronic Systems

1.03 REFERENCES

- A. ASME B31.9 – Building Services Piping; The American Society of Mechanical Engineers; (ANSI/ASME B31.9).
- B. ASTM A 53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- C. ASTM B 88 – Standard Specification for Seamless Copper Water Tube.

1.04 SYSTEM DESCRIPTION

- A. Contractor shall furnish and install all pipe, fittings, valves, hangers and appurtenances as required to provide a complete piping system.

- B. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary dielectric joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- C. Flanges or unions shall be installed adjacent to each control valve, trap or piece of equipment to permit removal of same from the line. In addition, unions or flanges shall be provided as required to make-up or disconnect piping. Each union shall be installed in a position permitting the valve, trap or piece of equipment to be removed by disconnecting the union and only a minimal amount of piping.
- D. In general, flanges shall be flat-faced where bolting to a flat-face flange, and raised-face where bolting to a raised-face flange, and they shall be of the same bore as the adjoining pipe. Gaskets are to be full face type for flat face flanges and ring type for raised face flanges.
- E. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- F. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.
- G. Use 3/4 inch gate or ball valves with hose end and cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- H. The Plumbing Contractor is required to provide any atmospheric vents for gas pressure reducing valves or gas train safety vents. This Contractor is required to coordinate with the Plumbing Contractor, the number and size of any such required vents.

1.05 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. See Section 23 0000 for low VOC submittal requirements.
- C. Product Data: Include data on pipe materials, pipe fittings, and accessories. Provide manufacturers catalogue information.

1.06 QUALITY ASSURANCE

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

- B. All welded piping joints of steel pipe, valves and fittings are to be welded in accordance with ASME Code B31.9 "Building Service Piping" latest revision. Welded details for pipe, valves and fittings shall conform to approved welding standards.
- C. It is required that all welding and brazing of piping covered by this Specification, regardless of condition of service, be installed as follows:
 - 1. Pipe welding shall comply with the provisions of the latest revision of the ASME Boiler and Pressure Vessel Code, and the ASME Code B31.9 "Building Services Piping" latest revision, or such State or Local requirements as may supplement codes mentioned above.
 - 2. Before any pipe welding is performed, the Contractor shall have in his files, a copy of his welding procedures specifications together with proof of its qualification as outlined and required by the most recent issue of the code having jurisdiction.
 - 3. Before any operator shall perform any pipe welding, the Contractor shall have in his files the welder's performance qualification record in conformance with provisions of the code having jurisdiction, showing that the welder was tested under the proved Procedure Specification submitted by the Contractor.
 - 4. Each Manufacturer or Contractor shall be responsible for the quality of welding done by his organization and shall repair or replace any work not in accordance with these Specifications.
 - 5. Any and all certification costs must be paid for by this Contractor.

1.07 REGULATORY REQUIREMENTS

- A. All piping materials furnished and all procedures followed in fabrication and erection shall comply with the applicable sections of the Local Building Code, applicable Pressure Piping Code, and requirements of applicable section of "Building Services Piping", ASME B31.9, latest revision and addenda.
- B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.08 DELIVERY, STORAGE, AND HANDLING

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

PART 2 – PRODUCTS

2.01 SCHEDULE OF PIPING

SERVICE	CONDITIONS	MATERIALS	JOINT	FITTINGS	FLANGES OR UNIONS
Heating Water 2-1/2" and Larger (In Equipment Room and to Major Equipment)	30 psig	Schedule 40 Black Steel ASTM A-53	Butt Welded	Standard Weight Welded	150# Welded Neck
Heating Water 2" and Smaller (In Equipment Room)	30 psig	Schedule 40 Black Steel ASTM A-53	Screwed	150# Black Malleable Iron	300# Black Malleable Iron Union
Heating Water (Exterior to Equipment Room)	30 psig	Hard Temper Copper Type "L"	Soldered Or Press Connected	Wrought	Solder Union Dielectric Where Material Changes
Relief Valve Discharge Line (Heating Water)	30 psig	Schedule 40 Galvanized Steel ASTM A-53	Screwed	150# Galvanized Malleable Iron	150# Galvanized Malleable Iron

2.02 NOTES

- A. Concealed runouts in walls on heating water or cooling water systems may be soft copper at the Contractor's option.
- B. Gasket material shall be 150# or 300# type, 1/16 inch thick. For 300#, Flexitallic gaskets may be used.
- C. At Contractor's option, piping within Mechanical Rooms may be copper. Provide dielectric unions or dielectric flanges where copper pipe connects to different pipe or equipment material.
- D. All plugs for all services shall be brass.

- E. Slip-on flanges will be acceptable at Contractor's option, where weld neck flanges are specified. Internal and external weld will be required.
- F. Hex head bolts and nuts shall be used for flanged connections.
- G. At Contractor's option, mechanical grooved products may be used on all water services within the temperature range of -30 degrees F to 230 degrees F.
- H. Materials shall be as follows and as manufactured by Victaulic, Anvil or Central Sprinkler Company:
 - 1. Couplings: Malleable iron, ASTM A47 or ductile iron ASTM A-536 with ASTM A-183 bolts and nuts with EPDM "E" gasket, Victaulic Series 07 Zero-Flex rigid coupling.
 - 2. Flanges: Malleable iron ASTM A47 or ductile iron ASTM A-536 hinged, two-piece design, suitable for opening and engaging the grooves.
 - 3. Fittings: Malleable iron, ASTM A47 or ductile iron ASTM A-536 full flow fittings with grooved or shouldered ends. Series 77 and 07
- I. It is required that all grooved end pipe, fittings and valves shall be prepared and installed in accordance with the manufacturer's latest published standard specifications and as follows:
 - 1. Pipe shall be prepared in accordance with the latest Manufacturer's standard roll/cut groove specifications; refer to Victaulic's "Field Assembly and Installation Instruction Pocket Handbook". Standard weight pipe shall be roll grooved without metal removal or square cut. Lightwall pipe shall be rolled grooved without metal removal.
 - 2. The nominal outside diameter of groove pipe shall not vary more than the tolerance listed. Maximum allowable tolerance from square cut ends is 0.030 inch for sizes 3/4 inch through 3 inch; 0.045 inch for sizes 4 inches through 6 inches; and 0.060 inches for sizes 8 inches and above; measured from true square line.
 - 3. Pipe shall be checked to be certain it is sufficiently free of indentations, projections, roll marks, weld seams on the exterior of the pipe and the entire gasket seating area to assure proper seating of gasket.
 - 4. Groove width, depth and outside diameter must conform to the standard groove specifications in the latest Manufacturer's "Field Assembly and Installation Instruction Pocket Handbook".
 - 5. Lubrications shall always be used for proper coupling fitting assembly.
- J. For a branch connection from a main at least two pipe sizes smaller than the main, approved weldolet or Thredolet or Victaulic style 920 bolted branch outlet may be used. Branch connection shall be welded or screwed depending on the piping specification hereinafter. Welded nipple into the main will not be allowed.
- K. Copper tubing shall conform to ASTM B88. Tubing shall be cut with pipe cutters and not hacksaws. After cutting, the tubing shall be sized with a sizing tool.

- L. Copper fittings shall be wrought copper or cast brass and conform to ASME B16.18 or B16.22 latest revision.
- M. Male adapters shall be used wherever it is necessary to connect copper tubing to a valve or tee having threaded connections. The adapters shall be soldered to the copper tubing. No threads shall be cut in copper tubing.
- N. Lead free solder used for connections in copper tubing shall be 95/5 tin antimony, 94/6 or 96/4 tin-silver or Silvabrite 100 (tin, copper and silver) solder with recommended flux (50/50 lead/tin solder is not acceptable). Other joint connections for special service lines are noted elsewhere in the Specifications.
- O. For copper tubing 2" and smaller, a press fit pipe joining system may be used. System shall consist of engineering copper fittings with EPDM O-Rings seals which when crimped, provide a high strength connection. System shall be rated for temperatures of 0°F to 250°F and pressures to 200 psi. System equal to Viega N.A. ProPress is acceptable.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions. Clean piping by blowing out with compressed air or other approved method.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. All piping shall be installed in accordance with the recognized best practices of the trade. The Contractor shall be held responsible for sufficient planning and foresight in avoidance of obstacles and interferences met in the field. Piping shall be installed parallel to planes of the building structure and must be level and plumb, or pitched as required by good engineering practice.

- C. Piping shall be fabricated of materials and be of schedule and/or dimensions as indicated on the Drawings and Material Specifications as separately listed and shall be the longest length commercially available. All pipe and fittings shall have the manufacturer's identifying mark stenciled, stamped or rolled onto the surface in accordance with latest ASTM Specifications.
- D. Fittings shall be used for all pipe lines and unless otherwise specified shall conform to latest ASME Code B31.9 "Building Services Piping", latest revision and Materials Schedule. Unless otherwise noted all butt welded elbows are to be long radius type.
- E. All pipe ends shall be reamed to full size and all threads shall be cleanly cut and tapered. Joints in screwed piping shall be made with approved pipe thread compound applied to male thread only to avoid leaving compound inside the pipe. Teflon tape is acceptable except if the system contains a glycol fluid, in which case a tape compatible with a glycol solution may be used.
- F. All piping shall be cleaned out before installation by blowing out with compressed air or by other approved methods. Provide temporary plugs or caps for all open ends of pipe when work is not being carried on to completion.
- G. All connections, vents, drains, etc. must be installed as required.
- H. Provide tapped elbows or other necessary fittings to allow installation of thermowells, sensors, flow switches, pressure switches, etc. as furnished by the Temperature Control Subcontractor and installed by this Contractor. Most wells are not shown. Verify number and location with the Control Subcontractor.
- I. In general, all overhead piping shall be installed as high as possible to provide maximum head room.
- J. Provide vents on high points of system where necessary to facilitate the filling to the system and to insure the flow of fluids when the system is in operation. Provide drain valves on low points of the piping (horizontal piping over 1-1/2 inch in size and over 40 feet long and on main vented risers) for draining purposes. Provide hose caps on hose end drain valve.
- K. When installing piping in parallel, sufficient space shall be left between pipe lines to facilitate future work on one of the lines.
- L. Tests shall be as called for in the above codes and material Specifications and shall be adhered to. Pipe, valves, fittings, etc. shall be hydrostatically tested in accordance with latest ASME.B31.9 "Building Services Piping", latest revision. The requirements of hydrostatic tests, indicated herewith, will be considered met if the hydrostatic tests applied to the erected piping system are completed to the satisfaction of the Engineer.

- M. When hydrostatic tests are applied to any piping section, a log shall be kept by the Contractor. Log shall state section of pipe, ultimate use of pipe, hydrostatic tests pressure applied, length of test, date and time applied. Log shall be signed by the Contractor's superintendent and retained by the Contractor.
- N. Tool marks will not be permitted on work in finished areas.
- O. Welding of galvanized pipe or fittings will not be acceptable.

END OF SECTION 23 2113

SECTION 23 2114 – HYDRONIC SPECIALTIES

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Expansion Tanks
- B. Air Vents
- C. Pump Suction Fittings
- D. Relief Valves
- E. Flexible Couplings

1.02 RELATED SECTIONS

- A. Section 23 0000 – Basic Heating, Ventilation & Air Conditioning (HVAC) Requirements
- C. Section 23 2113 – Hydronic Piping

1.03 REFERENCES

- A. ASME (BPV VIII, 1) – Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers.

1.04 SYSTEM DESCRIPTION

- A. Furnish and install all specialties required for the complete forced hot water system. Equivalent specialties as manufactured by Bell and Gossett, Armstrong, Hoffman, Taco, Mepco, Thrush/Amtrol, Wessels, or as noted are acceptable.

1.05 SUBMITTALS

- A. See General Requirements for submittal procedures.
- B. See Section 23 0000 for low VOC submittal requirements.
- C. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- D. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.

- E. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section.

1.07 DELIVERY, STORAGE, AND HANDLING

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

1.08 MAINTENANCE SERVICE

- A. Furnish service and maintenance of glycol system for one year from date of substantial completion.
- B. Perform quarterly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

1.09 EXTRA MATERIALS

- A. See General Requirements for additional provisions.

PART 2 – PRODUCTS

2.01 EXPANSION TANKS

- A. Install ASME compression tank of the pressure diaphragm type complete with air charging valve and drain valve, and properly connect tank into system. Provide supporting steel for expansion tank as required. Size is indicated on the Drawings.

B. Manufacturers:

1. Amtrol Inc.
2. ITT Bell & Gossett
3. Taco, Inc.
4. Substitutions: See General Requirements

C. Construction: Closed, welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); cleaned, prime coated, and supplied with steel support saddles; with tappings for installation of accessories.

D. Gage Glass Set: Brass compression stops, guard, and 3/4 inch red line glass, maximum 24 inches length, long enough to cover tank for 2 inches above bottom to 2 inches below top.

E. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

A. Automatic air vent in steel piping shall be Armstrong Model 21-AR, ball float trap. For copper piping, automatic vent shall be Maid-O-Mist Model 7 auto-vent. Provide ball valve on vent inlet connection and drain line on outlet. (Pet cocks are not acceptable.) Manual air vent shall be Maid-O-Mist Model 72.

B. Manufacturers:

1. Armstrong International, Inc.
2. ITT Bell & Gossett
3. Maid-O-Mist
4. Taco, Inc.
5. Spirotherm, Inc.

2.03 SUCTION DIFFUSERS

A. Provide a suction diffuser on each end suction pump. Each unit shall consist of an angle type body with inlet vanes, orifice, cylinder and disposable fine mesh start-up and standard strainer. Pressure drop through each unit shall not exceed three (3) psi at specified flow rate. Body of diffuser shall fit pump and connecting pipe size. Each unit shall be provided with adjustable support foot to carry weight of suction piping at pump inlet, and be mounted on pump inertia base.

- B. This Contractor shall be responsible for providing all labor, materials, etc., required for replacing the start-up strainer after the pump has been operating for thirty (30) days, and clean standard strainer before balancing of the system and after one hundred twenty (120) days, as well as any additional attention to the strainer that may be required in addition to those listed above.
- C. Manufacturers:
1. ITT Bell & Gossett
 2. Armstrong International, Inc.
 3. Taco, Inc.
 4. Mepco
 5. Thrush/Amtrol
 6. Anvil International Inc.
 7. Victaulic Company of America
 8. Substitutions: See General Requirements
- D. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- E. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.14 FLEXIBLE COUPLING

- A. Provide a flexible coupling at the following locations:
1. All base mounted pumps, suction and discharge connections.
 2. Cooling tower connections.
- B. Coupling shall have integral duct and rubber flanges and shall have individual solid steel ring reinforcement with a carcass of highest grade woven cotton or acceptable synthetic fiber. Coupling shall be of pipeline size and for working pressure of 125 psig on closed system. Construction shall be of the arch-type with a coating to prevent ozone attack. Control unit shall be provided with all couplings to prevent excessive movement. Flexible coupling shall utilize Teflon material and Monel reinforcing rings. Unit shall be Resistoflex Model R6904 flexible coupling.
- C. In lieu of the above specified coupling, stainless steel flexible connector with carbon steel flanges heli-arc welded on each end is acceptable. Unit shall be fabricated with multi-ply No. 304 stainless steel bellows element and provided with tie rods to assist in protecting against distortion. Rods shall be provided with neoprene washers. Unit shall be Senior Flexonics HPC-R flanged connector. Pressure and temperature ratings as previously specified.

- D. Flexible connectors 2" and smaller shall be stainless steel corrugated hose with stainless steel braid and Schedule 40 steel male threaded ends.

2.08 RELIEF VALVES

- A. Provide relief valve, ASME rated, set at pressure and with capacity as indicated on the Drawings. Valve as manufactured by Consolidated, Fisher, Kunkle, Crosby, Bell and Gossett or Watts is acceptable.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents as indicated.
- C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- D. Support pump fittings with floor mounted pipe and flange supports.
- E. Provide relief valves on pressure tanks.
- F. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- G. Pipe relief valve outlet to nearest floor drain.

END OF SECTION 23 2114

SECTION 23 2123 – HYDRONIC PUMPS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. In-Line Pumps

1.02 RELATED SECTIONS

- A. Section 23 0513 – Motors for Mechanical Equipment
- B. Section 23 0548 – Vibration & Seismic Control for HVAC Piping and Equipment
- C. Section 23 0716 – HVAC Equipment Insulation
- D. Section 23 0719 – HVAC Piping Insulation
- E. Section 23 2113 – Hydronic Piping
- F. Section 23 2114 – Hydronic Specialties

1.03 REFERENCES

- A. NFPA 70 – National Electrical Code; National Fire Protection Association.

1.04 PERFORMANCE REQUIREMENTS

- A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.05 SUBMITTALS

- A. See General Requirements for submittal procedure.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- D. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

1.07 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the authority having jurisdiction or UL 778 as suitable for the purpose specified and indicated.

PART 2 – PRODUCTS

2.01 IN-LINE PUMPS

- A. Manufacturers:
1. Armstrong Pumps Inc.
 2. Aurora Pump
 3. Grundfos Pump Corporation
 4. Wilo
 5. ITT Bell & Gossett
 6. Taco Pump
 7. Thrush/Amtrol
 8. Substitutions: See General Requirements
- B. Pump shall be bronze or stainless steel fitted construction with a brass, stainless steel or bronze impeller, cast iron volute and steel pump shaft, mechanical seals and provided with companion flanges.
- C. Bearings in the pump and motor shall be bronze sleeve or ball bearing. Motor shall be mounted resiliently in a rubber ring and be provided with built-in overload protection.
- D. Any in-line pump mounted horizontally, which is 1/8 HP or more, shall be supported from the bearing assembly by a hanger rod with a rubber-in-shear vibration isolation.
- E. On a single pump operation, the pump shall not overload the motor if the specified flow rate (gpm) is doubled. On a parallel pump operation, the pump shall not overload the motor on any point throughout the head capacity curve.

2.02 END SUCTION PUMPS

- A. Manufacturers:
1. Armstrong Pumps Inc.

2. Aurora Pump
 3. Wilo
 4. Bell & Gossett
 5. Taco Pump
 6. Thrush/Amtrol
 7. Sterling Fluid Systems (USA), Inc. (Peerless Pump)
 8. Substitutions: See General Requirements
- B. Pump shall be provided with cast iron or heavy gauge steel base with anchoring holes. Pump shall operate at maximum speed indicated on the schedule and be constructed as follows: cast iron casing, flanged suction and discharge connections, motor-pump connection of a non-metallic flexible coupler, and regreaseable ball bearing lubrication system on both the pump and motor.
- C. Pump shall be vertical split case design, bronze fitted construction with steel shaft, bronze or stainless steel shaft sleeves, bronze impeller, with impeller locked and keyed to shaft, and replaceable bronze casing wearing ring.
- D. A pump shall not overload its motor on any point throughout the head capacity curve.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Provide water circulating pump as scheduled on the Drawings.
- B. Install in accordance with manufacturer's instructions.
- C. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- D. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Refer to Section 23 0548.
- E. Provide valves and specialties as shown on the Flow Diagram.
- F. Provide air cock and drain connection on horizontal pump casings.
- G. Provide drains for bases and seals, piped to and discharging into floor drains.
- H. Lubricate pumps before start-up.

- I. Pump shall be guaranteed for 125 psi working pressure, 225 degrees F water temperature on heating water systems and shall be tested and rated in accordance with the procedures of the Hydraulic Institute. Provide tapped connections in the flanges for installation of pressure indicating gauges.
- J. Pump selection shall be made near the mid range of the pump curve and shall not be near the end point of the pump curve. On open system, selection of pump shall be that required net positive suction head does not exceed the net positive head available.
- K. Special note should be taken of the fact that certain pumps are designed for continuous running in parallel operation. That is, each pump was chosen to handle 1/2 of the total system GPM at the total system head. Special care must be exercised in selecting the pump motors for parallel operation, so that motor overloading will not occur in the case where only one pump is operating. Pump curves shall be submitted indicating pump operation in parallel, only one pump operating, and system curve.
- L. Do not use service factor of motor when determining non-overloading operation.
- M. Mechanical seal shall be suitable for the temperatures noted above and the service scheduled.
- N. Motor shall be NEMA construction, open drip-proof type.
- O. Provide guard over exposed rotating couplings for personnel protection.
- P. Any pump 7.5 HP and over that is controlled by a variable frequency drive, shall be provided with shaft grounding rings.

END OF SECTION 23 2123

SECTION 23 6533 - FORCED DRAFT CLOSED CIRCUIT COOLING TOWERS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Cooling Tower
- B. Controls

1.02 RELATED SECTIONS

- A. Section 22 0513 - Motors for Mechanical Equipment.
- B. Section 22 0548 - Vibration Isolation.
- C. Section 23 0583 - Testing, Adjusting and Balancing.
- D. Section 23 2113 - Hydronic Piping.

1.03 REFERENCES

- A. CTI STD-201 - Certification Standard for Commercial Water Cooling Towers; Cooling Technology Institute.

1.04 SYSTEM DESCRIPTION

- A. This section is based on specific selections of equipment. These selections relate to the selection of related equipment, Section 23 2123 - HVAC Pumps. In substituting equipment, ensure that performance selection criteria, matches that specified or that the selection of related equipment is acceptable or is revised to suit.
- B. Capacity:
 - 1. See Schedule on Drawings
- C. Motor: Refer to Section 22 0513
- D. Disconnect Switch: Factory mount disconnect switch in control panel.
- E. Provide a forced draft closed circuit cooling tower with up-blast discharge and side intake.
- F. The tower casing shall be galvanized steel fabricated and installed by manufacturer to make tower watertight.

- G. The combination fan section shall be constructed with galvanized steel. The pan section shall be constructed of stainless steel. The fans and motors shall be located in the dry air stream.
- H. Surface section shall be removable from the pan/fan section to facilitate rigging. Provide serpentine PVC wet deck surface, and galvanized casing steel panels.
- I. Eliminators shall be PVC and shall limit drift losses to 0.002 percent of total water circulated.
- J. Water Distribution System: One of the following materials designed and installed by manufacturer to ensure even distribution of water over wetted-surface-fill.
 - 1. Schedule 40 PVC pipe header and Schedule 40 PVC pipe branches.
 - 2. Nozzles: Provide removable plastic or brass.
- K. Air inlet screens shall be galvanized steel mesh, mounted in removable frames by manufacturer.
- L. Provide forward curved centrifugal fans with galvanized steel blades and V-belt drive with sheave sized for rated air flow. Provide with VFD for capacity modulation.
- M. Fan Bearings: Self-aligning ball bearings; include external extended grease lines, and fittings. Installed by manufacturer.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, dimensions, weights and point loadings, accessories, required clearances, electrical requirements and wiring diagrams, and location and size of field connections. Submit schematic indicating capacity controls.
- C. Shop Drawings: Indicate suggested structural steel supports including dimensions, sizes, and locations for mounting bolt holes.
- D. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
- E. Manufacturer's Certificate: Certify that cooling tower performance, based on CTI ATC-105 meets or exceed specified requirements and submit performance curve plotting leaving water temperature against wet bulb temperature.
- F. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories.

- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Manufacturer shall certify that performance of cooling towers will meet contract requirements, stating entering air wet bulb temperature, entering and leaving condenser water temperatures, water flow rates, fan kW (horsepower), and pump head at base of tower. Certification shall be made at the time of submittal.
- B. Cooling Tower Institute (CTI) Certified Towers: These towers shall have been tested, rated, and certified in accordance with Cooling Tower Institute (CTI) Standard 201, and shall bear the CTI certification label.

1.07 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.08 DELIVERY, STORAGE, AND PROTECTION

- A. Factory assemble entire unit. For shipping, disassemble into as large as practical sub-assemblies so that minimum amount of field work is required for re-assembly.
- B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.09 WARRANTY

- A. Vendor will replace or repair F.O.B. manufacturer's plant any part of the equipment furnished and proved to be defective in material or workmanship within one (1) year from the date of initial start-up. For first year warranty, installation of any part shall be included.
- B. Vendor guarantees equipment to meet the performance requirements stated.

1.10 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Baltimore Aircoil Company
- B. EVAPCO, Inc.

- C. Marley Cooling Technologies
- D. Substitutions: See Section 01 6000 - Product Requirements

2.02 MANUFACTURED UNITS

- A. Provide units for outdoor use, factory assembled, counterflow, vertical discharge, blow through design, with fan assemblies built into pan and casing.

2.03 COMPONENTS

- A. Pan: Stainless steel with bolted joints sealed watertight.
- B. Casing: Heavy gauge G-235 galvanized steel with bolted joints.
- C. Fans: Forward curved centrifugal type mounted on steel shaft with belt drive and bearings with extended grease fittings.
- D. Motor: Rated for variable speed, and provided with factory installed VFD. Motor to be provided with shaft grounding ring and internal heaters.
- E. Belt Drive: Designed for minimum 150 percent motor nameplate power.
- F. Fan Guard: Welded steel rod and wire guard, hot dipped galvanized after fabrication.
- G. Distribution Section: Schedule 40 PVC pipes with ABS plastic spray nozzles.
- H. Drift Eliminators: Replaceable PVC drift loss limited to 0.002%.
- I. Float Valves: Brass or bronze balanced piston type make-up valve with plastic or copper float.
- J. Hardware: Galvanized steel or stainless steel nuts, bolts, washers, and nails; assembled with phenolic epoxy coated, cadmium plated washer head fasteners.
- K. Heat Transfer Coil: Heavy gauge G-235 galvanized steel encased in a steel frame work with the entire assembly hot-dipped galvanized after construction.
- L. Pump: Closed coupled centrifugal type with mechanical seal and totally enclosed motor.
- M. Controls: Provide with BacNet controller for connection into control system by TCC.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide access and service space around and over cooling towers as indicated, but in no case less than that recommended by manufacturer.
- B. Install tower on structural steel beams as instructed by manufacturer. Steel support painting by others.
- C. Install roof-mounted units on structural steel mechanical equipment supports. Anchor cooling tower to supports with removable fasteners. Verify support configuration against tower shop drawing prior to tower delivery.
- D. Mount unit(s) on vibration isolators. Install gaskets or sealants between cooling tower cells. Level units to tolerance of 1/8 inch in 10 feet-0 inch, in both directions. Confirm with manufacture requirements for additional steel.
- E. Provide flanged or union connections to cooling tower, with flexible pipe connections when tower is mounted on vibration isolators. Connect inlets to cooling tower with shutoff valve, and balancing valve. Connect outlets with shutoff valves.
- F. Provide flanged or union connections to cooling tower, with flexible pipe connections.
- G. Connect drain, overflow, and chemical bleed lines to cooling tower as indicated, full size of connection on cooling tower. Bleed and drain to roof drain.
- H. Install electrical devices furnished by manufacturer but shipped loose. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

3.02 STORAGE

- A. Store tower and materials off ground until unit is placed. Follow manufacturers requirements for support.
- B. Perform all maintenance as required by manufacturer during storage until unit is turned over to Owner. Provide documentation on date and type of maintenance performed.

3.03 STARTING EQUIPMENT AND SERVICES

- A. Check, test and startup by manufacturer's technical representative, including final adjustments to blades and drives. Comply with manufacturer's instructions for filling and start-up of tower.

- B. Manufacturers representative shall attend pre-field assembly meeting to verify, in writing, that all tower parts have been shipped without damage and to instruct installing contractor on proper assembly.
- C. Manufacturers representative shall attend initial tower startup to verify, in writing, that the tower is properly assembled and fastened, the flow to the hot basins is properly balanced, the float valve operates properly, the fans operate properly through the entire speed range and the fan motors are drawing the proper amperage.
- D. Provide services of manufacturer's technical representative for one 8-hour day to instruct Owner's Personnel in operation and maintenance of factory-fabricated cooling towers.

3.04 WORK BY OTHERS

- A. The following work will be furnished by others:
 - 1. Complete wiring and electrical power supply.

3.05 MANUALS AND INSTRUCTION BOOKS:

- A. Four (4) complete set of installation, operation and maintenance manuals, and instruction books, including parts list and recommended list of stock spare parts with unit prices shall be furnished to the Owner at the time of start-up of the equipment.

END OF SECTION 23 6533