HYDRONIC HEATING SYSTEM
PROJECT SPECIFICATIONS

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END OF TABLE OF CONTENTS

SECTION 15000

SPECIAL REQUIREMENTS FOR MECHANICAL AND ELECTRICAL WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. This Section is coordinate with and complementary to the General Conditions, wherever applicable to Mechanical and Electrical Work.

B. Where items of the General Conditions are repeated in this Section of the Specifications, it is intended to qualify or to call particular attention to them; it is not intended that any other parts of the General Conditions shall be assumed to be omitted if not repeated herein.

C. This Section applies equally and specifically to all Contractors and Subcontractors supplying labor and/or equipment and/or materials as required under the Heating, Ventilating and Air Conditioning, Plumbing, Sprinkler and Electrical Sections of the Specifications.

1.02 DEFINITIONS

A. "The Contractor" or "Each Contractor" means specifically, the Contractor or Subcontractor working under his respective Section (Heating, Ventilating and Air Conditioning, Plumbing, Sprinkler or Electrical) of this Specification.

B. "Provide" means to supply, erect, install, and connect up in complete readiness for regular operation, the particular work referred to.

C. "Furnish" means to supply and deliver to the job.

D. "Piping" includes, in addition to pipe, all fittings, valves, hangers, and other accessories related to such piping.

E. "Concealed" means hidden from sight as in chases, furred spaces, shafts, hung ceilings, or embedded in construction.

F. "Exposed" means "not concealed" as defined above. Work in trenches, crawl spaces, and tunnels shall be considered "exposed" unless otherwise specifically noted.

G. "Approved equal" means any equipment or material which, in the opinion of the Architect, is equal in quality, durability, appearance, strength, design, performance, physical dimensions, and arrangement to the equipment or material specified, and will function adequately in accordance with the general design.

H. "Governmental" means all municipal, state and federal governmental agencies.

I. Where any device or part of equipment is herein referred to in the singular number (such as "the pump"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the Drawings.

J. References to General Contractor shall mean Construction Manager.

K. "HVAC" means Heating, Ventilating and Air Conditioning.

L. "Plumbing Contractor" means the Contractor doing Plumbing and Fire Protection Work including Sprinkler Work.

1.03 CODES AND STANDARDS

A. New York City Building Code

B. New York City Fire Protection Code

C. NFPA National Fire Protection Association

D. ASME American Society of Mechanical Engineers

E. ANSI American National Standards Institute

F. ASTM American Society for Testing Materials

G. AWWA American Water Works Association

H. IBR Institute of Boiler and Radiator Manufacturers

I. NEMA National Electrical Manufacturers Association

J. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers

K. SMACNA Sheet Metal and Air Conditioning Contractors National Association, Inc.

L. ARI Air Conditioning and Refrigeration Institute

M. UL Underwriters' Laboratories

N. AMCA Air Moving and Conditioning Association

O. ADC Air Diffusion Council

P. AABC Associated Air Balance Council

Q. 1980 National Standard Plumbing Code with all New Jersey State Amendments.

R. Local Water Company Rules and Regulations

S. NFPA-90A Air Conditioning and Ventilation Systems

T. National Electric Code and New York City Electric Code

1.04 INTENT

A. It is the intention of the Specifications and Drawings to call for finished work, tested, and ready for operation. All materials, equipment, and apparatus shall be new and of first-class quality.

B. Any apparatus, appliance, material, or work not shown on Drawings, but mentioned in the Specifications, or vice versa, or any incidental accessories, or minor details not shown but necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be provided without additional expense to the Owner.

1.05 DRAWINGS

A. The Drawings are generally diagrammatic and are intended to convey the scope of work and indicate general arrangement of equipment; ducts, conduits, piping, and fixtures.

B. The locations of all items shown on the Drawings or called for in the Specifications that are not definitely fixed by dimensions are approximate only. The exact locations necessary to secure the best conditions and results must be determined at the project and shall have the approval of the Architect before being installed. Do not scale Drawings.

C. Follow Drawings in laying out work and check Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom and space conditions appear inadequate, Architect shall be notified before proceeding with installation.

D. If directed by the Architect, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

E. Piping or ductwork connected to equipment may require different size connection than indicated on the Drawings. The Contractor shall provide transition pieces as required at the equipment.

1.06 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

A. Any questions or disagreements arising as to the true intent of this Specification or the Drawings or the kind and quality of work required thereby shall be decided by the Architect, whose interpretations thereof shall be final, conclusive, and binding on all parties.

B. In case of disagreement between Drawings and Specifications, or within either document itself, the better quality, greater quantity or more costly work shall be included in the Contract Price and the matter referred to the Architect's attention for decision and/or adjustment.

C. Maintain an awareness to avoid space conflict with other trades.

D. Purchase the equipment and material required in accordance with field measurements taken at the proper time during the construction progress.

1.07 VISITING THE SITE

A. Before submitting the final proposal, examine the site of the proposed work to determine the existing conditions that may affect the work, as this Section will be held responsible for any assumptions in this regard.

1.08 EQUIPMENT AND MATERIALS

A. The proposal and bid must cover all items on the Drawings and in the Specifications exactly as drawn and specified.

B. All proposed substitutions of equipment of other manufacturers than those specified shall be attached to the base bid in an itemized list. Directly opposite each item indicate the amount to be added to or deducted from the base bid if the proposal is accepted. Failure to furnish such an itemized list will be interpreted to mean that it is agreed to provide all items exactly as drawn and specified.

C. Substitutions of material and equipment of makes other than specifically named on the Drawings and in the Specifications and as provided for in the above paragraph will be approved for the following reasons only:

The material or equipment proposed for substitution is equal to or superior to that specified; and that the material or equipment called for on the Drawings or in the Specifications cannot be delivered to the job in time to complete the work in proper sequence to the work of other trades, due to conditions beyond control.

D. All pipe and fittings shall be manufactured in the United States of America.

E. To receive consideration, requests for substitutions must be accompanied by documentary proof of equality and difference in price and delivery, if any, in the form of certified quotations from suppliers of both specified and proposed equipment. In case of a difference in price, the Owner shall receive a credit and all benefits of the difference in cost involved in any substitutions.

F. The proposal and bid must cover all items on the Drawings and in the Specifications exactly as drawn and specified.

G. The words "or approved equal" shall be understood to apply only to those items of equipment and material listed under the paragraph "List of Approved Manufacturers" or as otherwise indicated on the Drawings or in the Specifications.

H. Within twenty (20) working days after the acceptance of the proposal, and prior to the submission of any shop drawings for review, a complete list of manufacturers shall be submitted to the Architect of all equipment and materials proposed for the work. No reviews will be rendered on shop drawings submitted before the complete list of manufacturers is reviewed.

I. If material or equipment is installed before the Contractor obtained "No Objections" comment from Architect, and/or in the opinion of the Architect the material or equipment does not meet the intent of the Drawings and Specifications, the removal and replacement shall be made at no extra cost to the Owner.

J. The materials, workmanship, design, and arrangement of all work installed under the Contract shall be subject to the approval of the Architect.

K. If material or equipment is installed before the Contractor obtained "No Objections" comment from the Architect, trade installing same shall be liable for the removal and replacement at no extra charge to the Owner if, in the opinion of the Architect, the material or equipment does not meet the intent of the Drawings and Specifications.

L. It is the intent of these Specifications that wherever a manufacturer of a product is specified, and the terms "other approved" or "or approved equal" are used, the substituted item must conform in all respects to the specified item. Consideration will not be given to claim that the substituted item meets the performance requirements with lesser construction (such as lesser heat exchange surface, etc.) Performance as delineated in schedules and in the Specifications shall be interpreted as minimum performance.

M. All equipment and materials required for installation under these Specifications shall be new and without blemish or defect. All electrical equipment shall bear labels attesting to Underwriters' Laboratories approval. Where no specific indication as to the type or quality of the material or equipment is indicated, a first class standard article shall be furnished.

N. Where it is proposed to use an item of equipment other than that specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring, or of any other part of the mechanical, electrical, or architectural layout, all such redesign, and all new drawings and detailing required therefore shall, with the review of the Architect and subsequent comments by the Architect "No Exception" or "Exception as Noted" on the shop drawings, be prepared at no additional cost to the Owner.

O. Where such deviation from contract documents requires a different quantity and arrangement of ductwork, piping, wiring, conduit, and equipment from that specified or indicated on the Drawings, furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring, and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

P. All equipment of one type (such as fan, coils, etc.) shall be the product of the same manufacturer.

Q. Note that the comments "No Exception" or "Exception as Noted" marked on the shop drawings or other information submitted in accordance with the requirements herein before specified does not assure that the Engineer, Architect, or any other Owner's representative attests to the dimensional accuracy or dimensional suitability of the material or equipment involved or the mechanical performance of equipment. Comments on the shop drawings do not invalidate the Plans and Specifications if the shop drawings are in conflict with the Plans and Specifications.

1.09 SHOP DRAWINGS

A. Prior to delivery to job site, but sufficiently in advance of requirements necessary to allow Architect ample time for review, submit copies (as stated in "General Conditions") of shop drawings of all equipment, materials, piping, sleeves, conduit, ductwork, and wiring diagrams, and further obtain written comments "No Exception" or "Exception as Noted" for same from the Architect, before installing any of these items.

B. For piping, sheet metal, sleeve layout, and reflected ceiling plan shop drawings, submit a sepia transparency. After the transparency is notated and corrected by the Architect, it will be returned. Then the required number of corrected prints will be prepared.

C. Shop drawings shall consist of manufacturer's certified scale drawings, cuts, or catalogs, including descriptive literature and complete certified characteristics of equipment, showing dimensions, capacity, code requirements, motor and drive testing, as indicated on the Drawings or Specifications.

D. Certified performance curves for all pumping and fan equipment shall be submitted for review.

E. Shop drawings submitted with insufficient information shall be rejected without review.

F. Shop drawings shall be either mailed or hand delivered to the Architect. Any shop drawing information transmitted by fax shall be rejected without review.

G. Shop drawings which are larger than 11" x 17" shall be submitted in the form of reproducible sepia with two prints. Shop drawings which are larger than 11" x 17" and which are not provided in the form noted shall be rejected without review.

H. Shop drawings submitted in insufficient number of copies shall be rejected without review.

I. Samples of materials or equipment, when requested by the Architect, shall be submitted for review.

J. Shop drawings, samples, specifications, etc. which are not labeled with all of the following information shall be rejected without review:
   1. Project name
   2. Project location
   3. Contractor's name and address
   4. Sub-Contractor's name and address
   5. Applicable section and article number of specifications
   6. Contractor's approval stamp and signature
   7. Submission number
   8. Specific service for which material is to be used.

K. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested, shall be specific and identification in catalog, pamphlet, etc., of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

L. Shop drawings indicating an unsuitable manufacturer shall be rejected without review.

M. Ductwork shop drawings shall be drawn with double line ductwork and shall indicate the elevation above finished floor of all ducts, location and height of building structure (beams, etc.), lengths of fabrication pieces and fittings. Show new and existing work. Shop drawings submitted shall be ready for sheet metal fabrication.

N. The comments "No Exception" or "Exceptions as Noted" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, said review does not in any way relieve responsibility, or necessity, of furnishing material or performing work as required by the Contract Drawings and Specifications.

O. "EXCEPTIONS, AS NOTED" means, unless otherwise noted on the drawings to approved for construction, fabrication and/or manufacture subject the provision that the work shall be carried out in compliance with all annotations and/or corrections indicated on the shop drawings and in accordance with the requirements of the Contract Documents. If also marked "RESUBMIT", "EXCEPTIONS AS NOTED" is invalid and a corrected submittal of the drawing is required.

P. If a shop drawing is resubmitted and does not comply with all of the comments indicated on the previous submission(s), and does not reflect specific reasons for such non-compliance, it shall be rejected without review.

Q. Label resubmitted shop drawings with a stamp indicating the submittal number, for example: SECOND SUBMISSION; THIRD SUBMISSION, etc. and send separate transmittals for each item being submitted so that one transmittal does not cover more than one specific item or group of items from one manufacturer.

R. Failure to submit shop drawings in ample time for checking shall not entitle an extension of Contract time, and no claim for extension by reason of such default will be allowed.

S. Prior to submission of shop drawings, thoroughly check each shop drawing, reject those not conforming to the Specifications, and indicate (by signature) that the shop drawings submitted meet Contract requirements. Deviations and/or exceptions to the contract documents should be clearly noted as being deviations and/or exceptions. The Contractor will later be required to correct such deviation and/or exceptions at his own expense, if they have not been noted and approved on the shop drawing.

T. All shop drawings showing routing of ductwork, piping and conduit, shall be not less than d" = 1'-0" scale.

U. Incorporate a numbering system to help keep track of shop drawing submittals as follows:
1. H HVAC shop drawings
2. P Plumbing shop drawings
3. E Electrical shop drawings

V. Concurrent numbers shall follow the prefix letter. Example: H-1, H-2, etc. In addition, shop drawings requiring resubmission should bear the number of the original submission and bear a suffix as follows: H-1A (second submission), H-1B (third submission), etc.

W. Before request for acceptance and final payment for the work, write a letter to the Architect stating that all shop drawings are brought to a condition "No Exception" or "Exception as Noted". Any outstanding shop drawings must be cleared with the Engineer.

X. The HVAC Subcontractor shall prepare ductwork shop drawings at d"=1'-0" scale and submit to the Architect for their approval to prepare the coordination drawings as called for in paragraph 1.13.

1.10 RECORD DRAWINGS

A. The Contractor shall furnish, coordinate, produce and distribute record drawings as stated within the General Conditions of the Contract.

B. During construction keep an accurate record of all deviations between the work as shown on the Drawings and that which is actually installed.

C. Secure from the Architect, a complete set of Mylar transparencies of the Drawings and note thereon all changes. Make a complete record of all changes and revisions in the original design which exist in the complete work. The cost for the Mylar transparencies shall be paid for by each trade.

D. Furnishing above transparencies and preparing these Record Drawings shall be at no additional cost to the Owner. When all revisions showing the work as finally installed are made, the corrected Mylar transparencies shall be submitted for review by the Architect.

E. After review of the "Record Drawings" transparencies by the Architect, provide the Owner with one set of black-line prints and Mylar transparencies, at no additional cost to the Owner.

1.11 LAWS, ORDINANCES, PERMITS AND FEES

A. Give all necessary notices, obtain all permits and pay all governmental taxes, fees, and other costs in connection with the work; file all necessary plans, prepare all documents, and obtain all necessary approvals of all governmental departments having jurisdiction; obtain all required Certificates of Inspection for the work and deliver to the Architect before request for acceptance and final payment for the work. File for and obtain all required equipment use permits, controlled inspections, backflow prevention device (BFP) sign-offs, boiler and domestic hot water heater filings with DEP and all other required filings.

B. Include in the work, without extra cost to the Owner, any labor, materials, services, apparatus, drawings, (in addition to Contract Drawings and Documents) in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on Drawings and/or specified.

C. All materials furnished and all work installed shall comply with the rules and recommendations of the National Fire Protection Association, with all requirements of local utility companies, with the recommendations of the fire insurance rating organization having jurisdiction, and with the requirements of all governmental departments having jurisdiction.

D. Include in the bid, without extra cost to the Owner, retaining the service of a licensed professional engineer to perform all required controlled inspections, equipment use permits, DEP BFP sign-off, and all DEP chimney & boiler submissions and approvals and all other required filings (NYC).

1.12 INDEMNIFICATION

A. Pay all royalties and defend all suits or claims for infringement of any patent rights and save the Owner harmless from loss on account thereof.

B. If process or article specified is an infringement of a patent, promptly notify the Architect in writing, and any necessary changes shall be as provided in the Contract for changes in the work. If the Contractor performs any work specified knowing it to be an infringement of patent, he shall bear all costs arising there of.

C. Take out all necessary insurance, free of extra charge, and agree to indemnify and save harmless the party contracting for services against loss or expense, by reason of the liability imposed by law upon such party for damages because of bodily injuries, including death at any time resulting there of, accidentally sustained by any person or persons or on account of damage to property arising out of or in consequence of the performance of this Contract, whether such injuries to persons or damage to property are due or claimed to be due to any negligence in the performance of the Contract, the party contracting for services, employees or agents, or any other person.

1.13 ORGANIZATION OF WORK

A. The work throughout shall be executed in the best and most thorough manner under the direction of and to the satisfaction of the Engineers, Owners and Architects, who will jointly interpret the meaning of the Drawings and Specifications, and shall have the power to reject any work and materials which, in their judgment, are not in full accordance therewith.

B. The work called for under this Contract shall be carried on simultaneously with the work of other trades in a manner such as not to delay the overall progress of the work. Furnish promptly to other trades involved at the project, all information and measurements relating to the work which they may require. Cooperate with them in order to secure the harmony necessary in the interest of the project as a whole.

C. Furnish and install all work as fast as possible to meet all construction schedules.

D. Keep a competent superintendent in charge of the work at all times. Such superintendent shall be replaced if unsatisfactory to the Owner.

E. Upon award of contract, consult with the Architect and negotiate with subcontractors and manufacturers, and within thirty (30) days submit five (5) copies of a preliminary list of major equipment, for approval, complete with name of manufacturer, dates of purchase orders, and delivery dates to the site. Also submit within thirty (30) days, five (5) copies of a preliminary schedule of installation of the various systems. This list shall be revised monthly and five (5) copies shall be submitted. The second submittal shall contain the names of manufacturers of scheduled equipment (with names, addresses, and telephone numbers of local representatives).

F. Maintain a complete file of shop drawings at all times available to the Owner's representative.

G. Every facility shall be provided to permit inspection of the work by the Owner's representative during the course of construction.

H. Where items of equipment and/or materials are indicated in the Specifications as being furnished by other trades for installation, assume responsibility for the unloading of such equipment and/or materials from the delivery trucks, and for providing safe storage for same as required pending installation.

I. Where the work is to be installed in close proximity to work of other trades, or where there is evidence that the work is to interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment.

J. If so directed by the Architect, prepare composite working drawings and sections at a suitable scale not less than d" = 1'-0" clearly showing how the work is to be installed in relation to the work of other trades. If the installation is made before coordinating with other trades, make all necessary changes in the work without extra charge to the Owner.

K. Before submitting shop drawings for sleeves, piping and ductwork, the Heating, Ventilating and Air Conditioning Subcontractor shall prepare a combined d" = 1'-0" scale shop drawing for piping and ductwork indicating location of piping and ductwork with dimensions for each floor and Mechanical Rooms. A transparent copy of these shop drawings shall be given to the Electrical Contractor. The Electrical Contractor shall indicate the location of all lighting fixtures and conduit runs on these shop drawings. The

Electrical Contractor shall give the transparent copy of these shop drawings, with lighting fixtures and conduit runs indicated to the Plumbing Contractor. The Plumbing and Sprinkler Contractor shall indicate his piping on these shop drawings. Each Contractor shall keep each transparent copy not more than three (3) working days.

L. The Heating, Ventilating and Air Conditioning Contractor shall arrange a Coordination Meeting for each floor and Mechanical Equipment Room with Plumbing and Electrical Contractors under the supervision of the General Contractor. After coordination, each Contractor shall sign the transparent copy. The Heating, Ventilating and Air Conditioning Contractor shall submit these drawings to the Architect for review and he shall call any conflicts that could not be resolved in the coordination meetings, and/or deviation from original design, to the Architect's attention. After receiving written review from the Architect, each Contractor shall prepare the shop drawings as required under the paragraph "Shop Drawings" in the Specifications.

1.14 PROTECTION OF WORK AND PROPERTY

A. Maintain and protect all equipment, materials and tools from loss or damage from all causes until final acceptance by the Owner.

B. Assume responsibility for the protection of any finished work or other trades from damage or defacement by the operations and remedy any such injury or damages.

1.15 TEMPORARY OPENINGS

A. Ascertain from examination of the Architectural Drawings whether any special temporary openings in the building will be required for the admission of apparatus provided under the Contract and notify the Architect accordingly. In the event of failure to give sufficient notice to the Architect in time to arrange for these openings during construction, assume all costs of providing such openings thereafter.

1.16 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such regular time or at overtime when designated by the Owner at no additional cost to the Owner.

B. The Owner shall be notified of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance, including overtime, when approved by the Owner, if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.17 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Install all work so that all parts required are readily accessible for inspection, operation, maintenance and repair. Minor deviations from the Drawings may be made to accomplish this, but changes of magnitude shall not be made without prior written review from the Architect.

B. Wherever mechanisms requiring access for maintenance, reading of instruments, or for operation are concealed in the structure and wherever else indicated on the Drawings, supply access doors of sizes necessary to provide ready access to the concealed items.

Group together valves, controls, dampers, traps, expansion joints, cleanouts, gauges, switches, and other equipment requiring access in walls and furred spaces to reduce the number of access doors.

C. Access doors shall be as specified under the General Construction Work. Provide fire rated access doors at fire rated shafts, stairwells, corridors and at all other walls with Fire Rating.

D. Access doors shall be installed in building structure under a separate Section.

E. All plumbing, electric and heating and ventilating access doors etc., shall be provided with master keyed cylinder locks. These locks shall be supplied and installed by the respective Contractor. These cylinder locks shall be purchased through the General Contractor's subcontractor for hardware after submission and review of the panel schedule as hereinafter specified.

F. Prepare a schedule showing location of all panels, cabinets, etc. to receive the Corbin lock. This schedule shall designate, by building and room number, the panel or cabinet location and shall be submitted to the Architect. This schedule is required for use in preparation of keying information. Locks shall not be purchased prior to review of this schedule.

1.18 PIPE EXPANSION

A. All pipe connections shall be installed to allow for freedom of movement of the pipe during the expansion and contraction without proper anchors and guides shall be provided where necessary and/or when shown on the Drawings. Anchors and guides shall be subject to the review of the Architect.

1.19 SCAFFOLDING, RIGGING, HOISTING

A. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of all equipment and materials furnished under this Section of the Specifications, and remove same from premises when no longer required.

B. In the event that supplementary bracing of the basic building structure is required to assure a secure rigging procedure and a secure route for the equipment being handled, assume full responsibility for such supplementary bracing.

1.20 BASES AND SUPPORTS

A. Provide all bases and supports not part of the building structure of required size, type and strength, as approved by the Architect, for all equipment and materials furnished by him. All equipment, bases, and supports shall be adequately anchored to the building structure to prevent shifting of position under operating conditions.

B. The Section furnishing the equipment shall provide not less than six-inch high concrete bases for all pumps, refrigeration machines, compressors, and rotating machinery. Bases shall extend six inches beyond machinery base in all directions, with top edge chamfered. Provide 2" x 6" steel dowels into floors to anchor bases. Provide anchor bolts set in pipe sleeves, two sizes larger than anchor bolts for securing machinery. After anchor bolts shall be aligned with equipment bases, fill sleeves with concrete and allow to cure.

C. New concrete pads shall be doweled into the existing concrete with 2“rods at corners, drilled 6" deep and grouted. An epoxy bonding agent shall be applied between the old and

new concrete. Concrete shall be 3000 psi reinforced with one middle layer 4 x 4 - w2.9 x w2.9.

1.21 SLEEVES, PIPE AND CONDUIT INSERTS AND ANCHOR BOLTS

A. Provide and assume responsibility for the location and maintenance in proper position of all sleeves, inserts, and anchor bolts required for the work. In the event that failure to do so requires cutting and patching of finished work, it shall be done without additional cost to the Owner.

B. All pipes and conduits passing through masonry walls or partitions shall be provided with sleeves having an internal diameter larger than the outside diameter of the pipe or insulation enclosing the pipe or conduit. Sleeves shall be Schedule 40 black steel pipe.

C. Sleeves through foundation walls shall be James B. Clow & Sons No. F-1430 or F-1435 cast iron wall sleeve with intermediate integral flange. Sleeves shall be set with ends flush with each face of wall. The space between sleeve and pipe shall be packed with a mechanical rubber seal, such as "Link Seal" manufactured by Thunderline Corp., (VICO) and then with oakum to within 2" of each face of the wall. The remaining space shall be packed and made watertight with a waterproof compound.

D. Sleeves through concrete floors or interior masonry walls shall be Schedule 40 black steel pipe, set flush with finished wall surfaces, but extending 2“above finished floors. The open sleeve space shall be packed with non-combustible materials.

E. Sleeves through non-masonry partitions shall be 22 gauge galvanized sheet steel, set flush with finished surfaces of partitions.

F. Inserts shall be preset concrete inserts with steel reinforced rods through the insert and both ends hooked over the reinforced mesh. Inserts shall be of individual type of malleable iron construction with accommodation for removable nuts and threaded rods up to :" diameter, permitting lateral adjustment, except as otherwise noted. Individual inserts shall be Grinnell Fig. 279 up to 5" pipe and conduit, Fig. 282, 6" and up to 8" pipe and conduit, Fig. 152 above 8" and up to 12" pipe and conduit. For figures 282 and 152, they shall come with an opening at the tip to allow reinforcing rods up to 2“diameter to be passed through the insert body. Rods shall extend a minimum of 4" on either side of the insert. Pipes larger than 12" shall be suspended from steel members only.

G. In general, all piping and conduit shall be supported from structural steel building members only or approved malleable steel inserts imbedded in concrete pours. All other loads shall be hung from steel building members. Inserts shall not be located in the same deck flute as ceiling tabs nor within 2 feet in any direction from ceiling tabs. Inserts shall not be spaced closer than 4 feet on center in all directions.

H. The Contractor shall have the option of providing 18 gauge sheet metal sleeves in lieu of Schedule 40 steel pipe.

I. Provide sleeves for pipes passing through roofs. Sleeves passing through roofs shall be as detailed on drawings extending min. 12" above finished roof. All pipes passing through roof shall be minimum of 10" from walls or other construction to permit proper flashing. Provide counter flashing.

J. Where sleeves pass through waterproofed floors, they shall be IPS brass pipe sleeves of the required diameter, brazed at the bottom to 18" x 18", 16-ounce copper flashing for bond with waterproofing. The tops of the sleeves shall extend 2“above finished floor.

K. No ductwork, piping, conduit or equipment shall be supported from corrugated decking construction. For this area provide supplementary steel to support ductwork, piping, conduit or equipment. Supplemental steel members shall be welded to building structural steel.

L. All hangers, rods and supports shall be installed prior to construction fireproofing.

M. The required fire resistance rating of floor or floor/ceiling assemblies and walls shall be maintained where a penetration is made for electrical, mechanical, plumbing pipes, conduits, ducts and systems. Fire stopping shall be provided at openings around vents, pipes, ducts, conduits at floor levels and walls with non-combustible materials. See the General Construction Specification for fire-stopping requirements.

1.22 ESCUTCHEONS

A. Provide escutcheons on pipes wherever they pass through ceilings, walls, or partitions.

B. Escutcheons or pipes passing through outside walls shall be Ritter Pattern and Casting Co., No. 1, solid, cast brass, flat type secured to pipe with set screw.

C. Escutcheons for pipes passing through floors shall be Ritter Pattern and Casting Co., No. 36A, split-hinged, cast brass type, designed to fit pipe on one end and cover sleeve projecting through floor on the other end.

D. Escutcheons for pipes passing through interior walls, partitions, and ceilings shall be Ritter Pattern and Casting Co., No. 3A, split-hinged, cast brass chromium plated type.

1.23 MANUFACTURERS' IDENTIFICATION

A. Manufacturer's nameplate, name or trademark, shall be permanently affixed to all equipment and material furnished under this Specification. Where such equipment is in a finished occupied space, the nameplate shall be in a concealed but accessible location. The nameplate of a Subcontractor or Distributor will not be acceptable.

1.24 EQUIPMENT NAMEPLATES

A. Provide for each item of equipment, including panel boards, disconnects, breakers, starters, switches, and all control devices, pumps, fans, compressors, boilers, etc., a permanently attached nameplate made of black surface, white core laminated bakelite with incised letters. Subcontractor furnishing equipment shall provide nameplate. Pneumatic, electric and mechanically actuated gauges shall have a brief, but complete description of their function. Stating the air pressure or voltage range alone is not acceptable. Nameplates shall be a minimum of 3" long by 12" wide and shall bear the equipment name and item number in 2" high white letters as designated in the equipment schedule. Mounting screws shall have chrome plated acorn headed screws.

1.25 TAGS AND CHARTS

A. Furnish and attach to each existing and new valve as hereinafter specified, a 12" diameter brass tag with 2“indented numerals filled with durable black compound. Tags shall be securely attached to stems of valves with copper wire and "S" hooks.

B. Valve charts shall consist of schematic drawings of piping layouts, showing and identifying each valve and describing the function. Upon completion of the work, one (1) copy of each chart, sealed to rigid backboard with clear lacquer placed under glass and framed, shall be hung in a conspicuous location in the main equipment room, unless otherwise directed by the Architect. Two (2) additional unmounted copies in 82" x 11" leather ring binders shall be delivered to the Architect. Also furnish three (3) copies of schematic flow chart with corresponding valve numbers noted on chart.

C. Provide tags for the following valves:
1. Zone control, bypass, shut-off, check and balancing valves.
2. Building and area shut-off and balancing valves.
3. Control, by-pass, shut-off, balancing and drain valves for major pieces of equipment such as boilers, domestic hot water heaters, heat exchangers, refrigeration machines, pumps, heating, ventilating and air conditioning units, cooling towers, etc.
4. System drain valves, safety and relief valves. Vacuum breakers.

1.26 IDENTIFICATION

A. Identification shall be in accordance with "Scheme for Identification of Piping System ANSI A13.1" and OSHA safety color regulation.

B. Markers shall be snap-on type as manufactured by Seton Nameplate Corp., New Haven, Conn. (Setmark System), Bunting Stamp Co. Inc., Pittsburgh, P.A. or approved equal. Markers shall completely encircle the pipe with a substantial overlap. No adhesive shall be used. They shall be manufactured of U.L. approved, self-extinguishing plastic. When the pipe, including insulation (if any), is larger than 6 inches diameter, markers shall be strap-on type. Markers for medical gas piping shall be by means of metal tags, stenciling, stamping or with adhesive markers, in a manner which is not readily removable.

C. Provide identification for existing and new piping, ductwork and conduit for electrical work.

D. Pipe shall be lettered and valves tagged in accordance with the schedule below. Lettering shall be located near each valve and branch connection and at intervals of not over 40 feet (10 feet on fire lines) on straight runs of pipe. Provide flow arrows for all piping at each marker. Adjacent to the legend, stencil the size of the pipe, conduit or ductwork. Letter Colors are as follows: Yellow with black letters, green with white letters, blue with white letters and red with white letters.

STENCIL AND VALVE TAG SCHEDULE

Service	Stencil Designation	Color	Tag Designation
Cold Water	Cold Water	Green	C.W.
Safety Valve Discharge	Safety V. Disch.	Yellow	S.V.D.
Relief Vent	Relief V.	Yellow	----
Low Pressure Steam	L.P. Steam----psi	Yellow	L.P.S.___psi
Low Pressure Condensate Return	L.P.Cond. Ret.	Yellow	L.P.C.R.
Pumped Condensate Return	Pumped Cond. Ret.	Green	P.C.R.

STENCIL AND VALVE TAG SCHEDULE			
Service	Stencil Designation	Color	Tag Designation
Heating Water Supply	Heat. Water Sup.	Green	H.W.S.
Heating Water Return	Heat. Water Ret.	Green	H.W.R.
Chemical Water Treatment	Chemical W.T.	Green	C.W.T.
Air Conditioned Supply Air	A.C. Supply Air	Green	----

E. Existing and new tanks, pumps, fans and other equipment shall be stenciled to show the number, if any, and service.

F. Except where other means of identification are specified, electric cabinets, switchboards, motor control centers, transformers, system control boards, disconnecting switches, remote control switches, individual motor starters and motor control pushbutton stations shall be stenciled to show the service and number, if any, of the equipment controlled, as appropriate. Panelboards and other electrical equipment located in finished areas, such as offices, shall have the identification placed on the inside of the cabinet doors.

G. Cabinet housing emergency lighting panelboards shall have the word "EMERGENCY" stenciled in 2-inch high red letters on the outside of the cabinet, in addition to other lettering required above.

H. The bolted covers of housings for disconnecting switches or links in bus ducts between network transformers and switchboards shall be lettered to identify the equipment within.

I. Serial numbers shall be stenciled on the tanks and covers of transformers having their nameplates attached to the high voltage switch chamber covers.

1.27 DRIP PANS

A. Examine the drawings, and in cooperation with the Electrical Work confirm the final location of all electrical equipment to be installed in the vicinity of piping. Plan and arrange all overhead piping no closer than three feet from a vertical line to electric switchboards, panel boards, or similar equipment.

B. Where the installation of piping does not comply with the requirements of foregoing paragraph, where feasible the piping shall be relocated.

C. Provide galvanized steel gutters as follows:
   1. Provide a gutter of 18 gage galvanized steel under every pipe which is within 2'-0" (two feet) of being vertically over any motor, electrical controllers, switchboards, panel boards, or the like.
   2. Each gutter shall be sealed and made watertight, properly suspended; and carefully pitched to a convenient point for draining. Provide a ： inch drain, to nearest floor drain or slop sink.
   3. In lieu of such separate gutters, a continuous protecting sheet of similar construction, adequately supported and braced, properly rimmed, pitched and drained, may be provided over any such motor, and extending 3'-0" in all directions beyond the motor, over which such piping has to run.

1.28 TOOLS

A. All special tools for proper operation and maintenance of the equipment shall be delivered to the Owner's representative and a receipt requested for same at no additional cost to the Owner.

1.29 QUIET OPERATION

A. All equipment and material shall operate under all conditions of load without any sound or vibration which in the opinion of the Architect is objectionable. Where sound or vibration conditions arise which are considered objectionable by the Architect, eliminate same in a manner reviewed by the Architect.

1.30 CLEANING, PIPING, DUCTS AND EQUIPMENT

A. Clean all piping, ducts, and equipment of all foreign substances inside and out before being placed in operation.

B. If any part of a system should be stopped by foreign matter after being placed in operation, the system shall be disconnected, cleaned, and reconnected wherever necessary to locate and remove obstructions. Any work damaged in the course of removing obstructions shall be repaired when the system is reconnected at no additional cost to the Owner.

C. During construction, properly cap all pipes and equipment nozzles so as to prevent the entrance of sand, dirt, etc.

D. Clean all existing piping, ducts and equipment of all foreign substances before painting or being placed in operation.

1.31 DELIVERY OF MATERIAL

A. Deliver the material and store same in spaces indicated by the Architect and assume full responsibility for damage to structure caused by any overloading of the material.

1.32 CUTTING AND PATCHING (IN EXISTING CONSTRUCTION)

A. All finished patching shall be done under another Section. Furnish the sizes and locations of all chases and openings required for the installation for his work before the walls, floors and partitions are built.

B. As a general rule, chases, shafts and wall openings as shown on the Drawings will be provided for most of the ducts and pipes. All other cutting and patching shall be provided by the trade providing the work.

C. Provide the labor and materials for all work included under the Contract or Subcontract in ample time and sufficient quantities so that all of the work of the Contract or Subcontract may be installed in proper sequence to avoid unnecessary cutting of the floors and walls.

D. Any cutting and patching required due to the failure to comply with the above provisions, shall be done at no extra cost to Owner. Such cutting and patching shall be done under Division One, as approved by the Architect.

E. Where existing piping or ductwork insulation are damaged by the requirements of the work, replace all damaged insulation to match existing.

F. Refer to Paragraph: "Sleeves, Inserts and Anchor Bolts" for additional requirements.

1.33 ALTERATIONS

A. When new work and alterations render equipment, piping and ductwork useless, such equipment, piping and ductwork when exposed to view, shall be removed and connections thereof to lines or ducts remaining shall be properly capped or plugged and left in construction. If construction, such as hung ceiling, furred beam, chase, etc., is opened up and removed during the course of the construction, the useless pipe and ducts therein shall be treated as though exposed to view. When required to accommodate new work, useless piping and ductwork concealed in construction shall be treated as though exposed to view.

B. When existing piping and duct systems, at points of connection to new work or in rerouting are found defective, such defective portions shall be removed and replaced with new materials without cost to the Owner.

C. Provide temporary supports where required.

D. Where alterations reveal piping, ductwork, conduit circuits, wiring, and accessories that must necessarily remain in service, same shall be rerouted, replaced or altered as required to make same completely concealed in the new work at no additional cost to the Owner.

E. Where existing piping or ductwork insulation is damaged by the requirements of the work, replace all damaged insulation to match existing.

F. Cutting in existing building shall be done by each Contractor as reviewed by the Architect. Rough patching shall be done by each Contractor. Finish patching, ceiling construction removal, new ceiling in existing building will be done under another Section.

1.34 PAINTING

A. All finish painting is specified under other Sections of the Specifications.

B. Painting Schedule
   1. No on-site painting is required on the following items unless specifically indicated otherwise:
      a. Stainless steel or monel sheet metal.
      b. Stainless steel or monel piping.
      c. Piping or ductwork to be insulated.
      d. Insulation on piping or ductwork in unfinished spaces or concealed.
      e. Insulated piping covered with stainless steel, aluminum or all service jacketing, unless otherwise specified.
      f. Insulated piping in walk-in and non-walk-in tunnels.
      g. Mechanical equipment with a factory applied baked-on enamel finish, not specified to be insulated or provided with an enameled steel insulated jacket.
      h. Insulated equipment or smoke stacks specified or noted on the Drawings to be covered with stainless steel or aluminum sheet metal jacketing.
      i. Factory fabricated multi-wall metal smoke flue piping.
      j. Concealed piping.
   2. Paint the following: Existing and New:
      a. Uninsulated Black Steel Piping:
         1) Exposed in Finished Rooms or Finished Spaces: 1 coat of primer and 2 coats of latex semi-gloss enamel.

2) Exposed in Unfinished Rooms, or Unfinished Spaces, or in Pipe Shafts: 1 coat of primer and 2 coats of finish.

3) Exposed Exterior to a Building: 1 coat of primer and 2 coats of exterior acrylic latex gloss enamel.

b. Uninsulated Galvanized, Cast Iron, Brass or Copper Piping:

1) Exposed in Finished Rooms or Finished Spaces: 1 coat of primer and 2 coats of latex semi-gloss enamel.

2) Exposed Exterior to a Building: 1 coat of primer and 2 coats of exterior acrylic latex gloss enamel.

3) Exposed in Unfinished Rooms or Unfinished Spaces: 1 coat of primer and 2 coats of finish.

c. Piping in floor trenches after fabrication: primer and finish.

d. Uninsulated Mechanical Equipment:

1) Furnished with a Factory Applied Prime Coat Finish: 2 coats of acrylic latex semi-gloss enamel. No primer required.

e. Vessels, Tanks, and Like Equipment Specified to be Insulated: l coat of corrosion resistant paint, prior to the application of insulation.

f. Uninsulated Exposed Iron and Steel Surfaces of Boilers, Including the Steel Casing, Buck Stays, Boiler Fronts, Castings, Smoke Pipes, Breeching and the Exposed Surfaces of all Other Iron or Steel Installed in Conjunction with Boiler Work: 1 coat of primer and 2 coats of heat resistant enamel.

g. Hangers, Supports and Accessories:

1) Exposed: Paint to match adjacent piping, pipe insulation or ductwork insulation.

2) All black steel or iron pipe hangers, rods, inserts, brackets and accessories for supporting piping systems and duct systems: 1 coat of primer and 2 coats of latex semi-gloss enamel. Paint black steel hanger rods, threaded on the job site, with a primer immediately after installation.

3) Metal Fabrications in Finished Spaces: Paint over shop coat with 2 coats of alkyd gloss enamel.

h. Sheet Metal Work:

1) Exposed Black Iron, Galvanized Iron, and Aluminum, including Hangers for Insulated and Uninsulated Ductwork, in Finished Rooms, Finished Spaces or Exterior to a Building: 1 coat of primer and 2 coats of latex semi-gloss enamel.

2) Jacketing on Exposed Insulated Ductwork in Finished Rooms and Finished Spaces: 2 coats of latex semi-gloss enamel. No primer required.

i. Uninsulated Exposed Valves, Flanges, Unions and Irregular Surfaces in Piping Systems Installed in Finished Rooms or Finished Spaces: 1 coat of primer and 1 coat of black heat resistant enamel.

j. Convector enclosures shall be painted at the factory as specified in Section 15835: Convectors.

k. Underground pipe, ducts and conduits - two coats of black asphaltum paint.

C. Color Coding:

1. Apply finish paints of colors indicated opposite the various items listed below where such items are installed in Mechanical Equipment Rooms, Machine Rooms, Boiler Rooms, Penthouse Mechanical Equipment Rooms:

Piping, Exposed - Bare and Insulated on Unfinished Spaces and Rooms:
Steam Supply (all pressures) ..... Yellow
Steam Condensate Returns ..... Orange

2. Ductwork: Grey.
3. Equipment - Bare and Insulated (Except Factory Painted): Grey.

D. The inside of all ductwork where visible through openings shall be painted with two prime coats of dull black paint.

E. Nameplates on all equipment shall be cleaned and left free of paint.

F. All lead bends and lead safes and flashing shall be painted with two coats of waterproof black asphaltum varnish.

1.35 LUBRICATION

A. Assume responsibility that all rotating equipment is properly lubricated as soon as it is connected by the Electrical Subcontractor before operation of this equipment is started. Assume responsibility for any damage to any equipment that is turned on without previously having been oiled or greased when connected up.

1.36 TESTS

A. All existing and new piping, wiring, and equipment shall be tested as specified under the various sections of the work. Labor, materials, instruments and power required for testing shall be furnished under the particular Section of the Specifications.

B. Tests shall be performed satisfaction of the Architect. The Architect will be present at such test, when he deems necessary and such other parties as may have legal jurisdiction.

C. Pressure tests shall be applied to piping only before connection of equipment and installation of insulation. In no case shall piping, equipment, or accessories be subjected to pressure exceeding their rating.

D. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the review of the Architect.

E. Any damages resulting from tests shall be repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Architect.

F. The duration of tests shall be as determined by all authorities having jurisdiction, but in no case less than the time prescribed in each Section of the Specifications.

G. Equipment and systems which normally operate during certain seasons of the year shall be tested during the appropriate season. Tests shall be performed on individual equipment, systems, and their controls. Whenever the equipment or system under test is interrelated with and depends upon the operation of other equipment, systems and controls for proper operation, functioning, and performance, the latter shall be operated simultaneously with the equipment or system being tested.

H. The electrical work shall include providing any assistance (such as removal of switchboard and panelboard trims and covers, pull and junction box covers, etc.) deemed necessary by the Architect to check compliance with the Drawings and Specifications.

1.37 OPERATING INSTRUCTIONS

A. Two months prior to the completion of all work and the final inspection of the installation by the Owner, five (5) copies of a complete Instruction Manual, bound in booklet form and suitably indexed, shall be submitted to the Architect for review. All written material contained in the manual shall be typewritten or printed.

B. The Manual shall contain the following items:

Table of Contents (Plumbing, HVAC and Electrical)

I. Introduction - Explanation of Manual and its use.

II. Description of Systems

1. Complete schematic drawings of all systems.
2. Functional and sequential description of all systems.
3. Relationship of system where applicable to the supervisory data system.

III. Systems Operation

1. Start-up procedures.
2. Shut-down procedures.
3. Reset and adjustment and balancing procedures.
4. Seasonal operation.
5. All posted instruction charts.

IV. Maintenance

1. Cleaning and replacement - lines, components, filters, strainers, ducts, fans, etc.
2. Lubrication.
3. Charging and filling.
4. Purging and draining.
5. Systems trouble shooting charts.
6. Instruments checking and calibration.
7. Procedures for checking out functions with remote (Supervisory Data Console) indication and control.
8. Recommended list of spare parts.

V. Listing of Manufacturers

VI. Manufacturer's Data (Where multiple model, type and size listings are included, clearly and conspicuously indicate those that are pertinent to this installation).

1. Description - Literature, drawings, illustrations, certified performance charts, technical data, etc.
2. Operation.
3. Maintenance - including complete trouble-shooting charts.
4. Parts List.
5. Names, addresses and telephone numbers of local recommended repair and service companies.
6. Guarantee data.

7. Model No. and Serial No. of all equipment.

1.38 INSTRUCTION OF OWNER'S PERSONNEL

A. After completion of all work and all tests and at such time as designated by the Architect, provide the necessary skilled personnel to operate the entire installation for a period of five (5) consecutive days eight (8) hours each.

B. During the operating period, fully instruct the Owner's representative in the complete operation, adjustment and maintenance of the entire installation.

C. Provide training on the operation and maintenance for equipment, as indicated within the equipment specification. If not indicated within the equipment specification section, provide the following training:
   1. Automatic Temperature Controls: Two (2) days.
   2. Where more than one (1) day is required, the Contractor shall schedule the first day and the Owner shall schedule all other days. All training shall be by factory authorized representatives, fully trained in the systems and the equipment operation and maintenance.

1.39 GUARANTEE

A. The Contractor guarantees by his acceptance of the Contract that all work installed will be free from any and all defects and that all apparatus will develop capacities and characteristics specified, and that if during a period of one year from date of completion and acceptance of work any such defects in workmanship, material or performance appear, he shall immediately replace, repair, or otherwise correct the defect or deficiency without cost to the Owner within a reasonable time. Notify the Architect in writing of the time required to do work. For heating systems the guarantee period must include one continuous heating season from November 1st to April 1st. For cooling systems the guarantee period must include one continuous cooling season from May 1st to October 1st.

B. Replace or repair to the satisfaction of the Owner any and all damage done to the building or its contents or to the work of other trades in consequence of work performed in fulfilling guarantee.

C. This Article is general in nature and will not waive stipulations of other claims which specify guarantee periods in excess of one (1) year.

D. In the event default on this Guarantee, the Owner may have such work done as required & charge the cost to the Contractor.

E. The date of acceptance shall be the date of final payment by the Owner or notice of acceptance by the Owner, whichever is later.

1.40 OPERATION PRIOR TO COMPLETION

A. The Owner may require operation of parts or all of the installation for the beneficial occupancy prior to final completion and acceptance of the building.

B. The operation shall not be construed to mean acceptance of the work by the Engineer for the Owner. The Owner will furnish supervisory personnel to direct operation of the entire system and the Contractor shall continue to assume this responsibility until final acceptance.

1.41 INSTALLATION OF MOTORS AND CONTROL EQUIPMENT

A. Motor Control Centers (MCC's) shall be furnished by the HVAC Sub-Contractor and shall be installed by the Electrical Sub-Contractor. The Electrical Sub-Contractor shall set and fully install the MCC on the concrete pad. Concrete pads shall be provided by the HVAC Sub-Contractor. (or General Contractor, check with Architect).

B. The Electrical Sub-Contractor shall furnish and install power wiring for all electrical devices, individual motor starters and MCC's, furnished to him at the job site by other trades.

C. The HVAC Sub-Contractor shall provide all wiring for the Automatic Temperature Controls, Combustion Control, Burner and Boiler Control, and condenser water treatment controls, except as otherwise specified herein.

D. The Electrical Sub-Contractor shall, except where otherwise noted, provide wiring for all Plumbing and Sprinkler Control and Alarm Systems. The Plumbing Sub-Contractor shall provide all devices in connection with same.

E. For single phase motors which are not interlocked with other motors and which have temperature control or motor control devices in the power circuit, furnishing of control devices, installation and wiring shall be by the Electrical Sub-Contractor.

F. For all HVAC 3-phase motors or HVAC equipment, temperature control wiring, motor control wiring and associated interlocks shall be provided by the HVAC Sub-Contractor, including the installation of all control devices. For all plumbing and sprinkler 3-phase motors, equipment control wiring, motor control wiring and associated interlocks shall be provided by the Electrical Sub-Contractor, including the installation of all control devices.

G. Electrically operated equipment supplied by other trades, which are to be installed and wired by the Electrical Sub-Contractor, shall be delivered with detailed instructions for their installation and wiring in sufficient time and proper sequence to meet the work schedule.

H. Each contractor shall furnish all electrical motors, starters and other motor control devices for motor driven equipment required for the work. In his work, the Electrical Sub-Contractor shall provide the code required disconnect switches for all motors, except where otherwise noted. The setting of all motors, required for mechanical equipment, including unmounted motors, shall be done as part of the mechanical work.

I. If a motor is replaced (even with the same horsepower) a new starter shall be provided for that motor.

J. Equipment which includes a group of electrical control devices mounted in a single enclosure or on a common base with equipment shall be supplied completely wired as a unit with terminal boxes or leads ready for external wiring.

K. All electrical items furnished and/or installed as part of the mechanical work shall conform to NEMA Standards, to the requirements of the National Fire Protection Association, and to the requirements of any local authority having jurisdiction. Any field modifications required to insure such conformance shall be included as part of the mechanical work.

L. The furnishing of floor mounted motor starting equipment shall include the purchase and delivery of channel sills for mounting.

M. Whether or not shown on the drawings, the Electrical Sub-Contractor shall furnish and install a local disconnect switch at each motor which is not in sight from the controller location.

N. The supplying of any and all "field instruction" diagrams deemed necessary by the Architect for the complete delineation of electrical wiring for mechanical equipment shall be included as part of the mechanical work.

O. The drawings describing the electrical or the mechanical work may include explanatory wiring diagrams indicating the function intended for the motor control circuits of certain motors. The "field instructions" wiring diagrams required as part of the mechanical work shall conform to these intended functions.

1.42 ELECTRIC MOTORS

A. Each Contractor shall provide all electric motors required for driving all motor driven equipment required to be furnished under his Section of the Specification.

B. All motors shall be designed for 3 phase, 60 cycle alternating current operation with 200 volts across the motor terminals, except that, unless otherwise specified herein, all motors a HP and smaller shall be designed for single phase, 60 cycle alternating current at 120 volts across the terminals. Before ordering motors, ascertain the actual voltages and other current characteristics that will be available and permissible for each motor. Report the same in writing to the Architect and obtain approval before ordering motors. The designation of current characteristics in these Specifications does not relieve the responsibility for ascertaining the actual conditions of electric service available for each motor or for the proper operation of all motors under the actual conditions.

C. The speed, horsepower, type and other essential data for each motor, if not given under paragraphs describing the various motor driven apparatus, or in schedules on the drawings shall be obtained from the manufacturer of the respective apparatus and shall be submitted to the Architect for his review. All two speed motors shall be single winding type.

D. Provide oversized motor junction box for 2 speed motors.

E. All motors shall be built in accordance with the latest rules of the National Electrical Manufacturers Assn., and of the Institute of Electrical and Electronic Engineers and also as hereinafter specified.

F. Motors 2 HP and larger shall have Class B insulation. All motors shall be rated for continuous duty and shall be designed for temperature rises not to exceed 55EC for fully enclosed type, 55EC for splashproof types and 40EC for all other motors excepting as otherwise specified herein. Motors shall be capable of withstanding momentary overloads of fifty (50%) without injurious heating. They shall operate without excessive heating, flashing or sparking under any conditions within the specified capacity of load and speed. All motors shall operate quietly and shall be replaced if, in the Architect's opinion, they do not do so. All motors which are in the airstream of air conditioning units, shall be totally enclosed type.

G. Motors 2 HP and larger shall have ball or roller bearings with pressure grease lubrication, except where otherwise noted.

H. Direct connected motors shall be furnished without an adjustable base. All motors connected to driven equipment by belt shall be furnished with adjustable sliding bases, except fractional motors with slotted mounting holes.

I. All motor leads shall be permanently identified and supplied with connectors.

J. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, speed, voltage, phase and current characteristics.

K. The insulation resistance between stator conductors and frames of motors at the time of final inspection shall be not less than one-half megohm.

L. All motors shall be of the proper type for the duty and shall have sufficient torque to start and run the equipment to which they are connected and starting currents and running currents shall not exceed the limits imposed by the laws or rules and regulations of the public authorities having jurisdiction or of the electrical utility company. All motors shall have sufficient horsepower capacity and rated duty to operate the apparatus to which they are connected so as to give the speeds and performances specified, but the horsepower shall be in no case less than that stated herein or shown on the drawings. A schedule giving the characteristics of the motors proposed for each type of service shall be submitted to the Architect for approval.

M. The maximum full load speed of each direct connected motor shall be suitable for the equipment it drives.

N. Except where V-belt drive is specified, the fan wheels for ventilating fans shall be mounted on the motor shafts, which shall be designed for this duty.

O. All motors except motors furnished as an integral part of equipment and factory installed on the equipment, shall be of same manufacture.

P. Polyphase motors shall be squirrel cage induction high efficiency energy saver type, suitable for the starting torque and current requirements.

Q. Single phase motors shall be of the capacitor start induction run or split phase type as required for proper operation of the driven equipment.

R. The efficiency of energy efficient motors shall be verified in accordance with NEMA standard MG1-12.53a. Minimum acceptable efficiency shall be as follows:

Rating	H.P.	Efficiency
200/460 Volts	5 HP	89.5%
3 Phase, 60 c/s	7.5 HP	91.7%
1.15 Service Factor	10 HP	91.7%
40E C. Ambient	15 HP	92.4%
	20 HP	93.0%
	25 HP	93.6%
	30 HP	94.1%
	40 HP	94.5%
	50 HP	94.5%
	60 HP	95.4%
	75 HP	95.4%
	100 HP	95.4%

125 HP	95.4%
150 HP	96.2%
200 HP	96.2%
250 HP	96.2%
300 HP	96.2%

1.43 INDIVIDUAL MOTOR STARTERS

A. For single-phase motors a HP or smaller, starters shall be manual, 120 volts, single-pole or 240 volts, 2-pole with thermal overload protection and pilot light. Where interlocking or automatic control (other than for unit and cabinet heaters) is required, starters shall be combination circuit breaker and magnetic starter with pilot light.

B. For 3-phase motors 2 HP and over, starters shall be full-voltage combination circuit breaker and magnetic across-the-line contactor, rated 208 volts, 3-pole. All magnetic starters shall have three thermal overloads.

C. Unless otherwise specified, motors 50 HP and over, rated 200 volts shall be furnished with reduced voltage starters of the autotransformer closed transition type.

D. For motors requiring electric interlocks, or automatic control features, starters shall be equipped with the necessary auxiliary relays and contacts to provide the control features desired. Such starters shall be also provided with "hand-off-auto" pushbuttons mounted in cover. For two-speed motors, provide "high-low-off-auto" four position selector switch. Furnish adjustable 20-second time delay between high and low speeds for motors 10 HP and above.

E. In addition to any auxiliary contacts required for interlocking purposes, each magnetic starter shall be equipped with one normally open auxiliary control circuit contact either for "sealing in" or as a spare for future use.

F. Indicating lights shall be transformer or series resistor type. There shall be one red light for each single speed motor to indicate when motor is running. For multiple speed motors one indicating light for each speed shall be provided.

G. The starter disconnecting means shall be circuit breakers. The external operating handle shall clearly indicate "ON" or "OFF" position of the switch and shall be interlocked with the door to require throwing the handle to the "OFF" position to open the door. The handle shall be arranged for locking both the door closed and the disconnect in the "OFF" position with up to 3 padlocks. Provide defeat device in cover to permit opening door in "ON" position.

H. Circuit breakers in combination starter units shall be of the magnetic trip type with an adjustable trip setting for selecting instantaneous trip points of fault protection (motor circuit protector). Field adjustment of the instantaneous trip shall be performed by the Electrical Contractor. Select the trip setting at approximately 10 times the motor nameplate full-load current. If the circuit breaker trips on starting, incrementally increase the settings. In no case shall the trip setting exceed 13 times the motor full-load current.

I. Overload heaters shall be furnished for all starters and shall be sized in range of 115 to 125 percent of full load current. The motor starters shall be shipped with the overload heaters inside the compartment but not installed. The Electrical Contractor shall verify the ratings of the heater coils based on the motor nameplate data before installing the overloads. The Contractor supplying the starter shall replace any improperly selected heaters.

J. A transformer shall be supplied in each starter unit for 120 volt control voltage. Transformer capacity shall be adequate to supply the holding coil requirements plus the solenoids, e-p switches, relays and other devices required to be controlled from the starter. A fuse shall be supplied in one secondary terminal of the control transformer. The other terminal shall be grounded to the housing of the starter. Fuses shall be also provided in the transformer primary leads per the National Electrical Code.

K. All enclosures shall be NEMA Type I sheet steel with hinged cover for general purpose indoor application, unless otherwise indicated. Enclosures shall be arranged for equipment or wall mounting. Weatherproof NEMA Type 4 enclosures shall be provided for all outdoor starters.

L. Each starter shall be clearly identified by engraved nameplates after installation. The nameplates shall be bakelite black plates with 2" high white letters and shall be securely fastened to starter with mounting screws made of non-corrosive metals.

M. Stainless steel flush mounted starter and enclosures shall be provided for all starters located in the kitchen and dishwasher areas.

N. All starters, except those furnished as an integral part of equipment and factory installed on the equipment, shall be of the same manufacturer.

O. Starters shall be as manufactured by Westinghouse, General Electric, Square D, Eaton/Cutler-Hammer, or Allen-Bradley.

P. Shop drawings shall be provided with dimensions, ratings, wiring diagrams and schedule of nameplates for approval prior to fabrication.

1.44 MOTOR CONTROLLERS

A. Motor controllers shall be defined as control devices such as pushbuttons, switches, etc. which are not mounted in starter cover, required for remote control of motors.

B. Unless otherwise noted, motor controllers shall be housed in NEMA Type 1 general purpose enclosures. Outdoor controllers shall be provided with weather proof NEMA Type 4 enclosures. Provide nameplate to indicate the motor with which they are associated.

C. Provide reduced voltage starters for all motors 10 HP and larger, and provide time delay for restart.

D. The controllers to be installed in finished area shall be flush mounted.

E. The Electrical Sub-Contractor shall install and provide wiring for motor controllers. The contractor providing the motor shall furnish the controllers.

F. Unless otherwise noted, pushbuttons shall be of the normal duty, spring return momentary type.

G. Selector switches and pushbuttons shall be equipped with nameplates indicating the function of each of their positions as noted in the list of electric motors and motor controls or shown on the drawings.

H. Pilot light shall be transformer or series resistor type for operation at 120 V.

I. Pilot lights shall be equipped with nameplates indicating the operating conditions they annunciate as noted in the list of electric motors and motor controls or shown on the drawings.

1.45 SEMI-FINAL AND FINAL SITE VISITS FOR OBSERVATION

A. As the project approaches completion, the Engineer and Architect, at their discretion shall determine a period of time in which they shall perform a Semi-Final Site Visit to observe the Mechanical and Electrical installation. At the conclusion of this Semi-Final Site Visit, a Semi-Final Punch list shall be issued to the appropriate Contractor for the deficiencies in the work of his trade. Complete all work and perform all corrective measures as required by the Semi-Final Punch list. After this corrective and completion work has been accomplished, in writing, advise the Architect and the Engineer that every item on the Semi-Final Punch list has been completed. After the Architect and Engineer make a Final Site Visit to observe the Mechanical and Electrical installation and make a Punch list, a similar letter of Compliance shall be forwarded through channels.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 15000

SECTION 15600

GENERAL PROVISIONS FOR HVAC WORK

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinated with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK INCLUDED

A. Work Included:

1. The work includes providing all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, all Heating, Ventilating and Air Conditioning Work as shown on the Drawings and hereinafter specified, including, but not limited to the following:
   a. Perimeter hot water heating system complete with cabinet unit heater, baseboards, distribution piping, controls, etc.
   b. Low pressure steam and condensate return piping system.
   c. All motor starters and controllers for equipment furnished by this Contractor. Packaged type units shall be furnished completely prewired with panels mounted on the units as specified. All other motor starters and controllers will be turned over to the Electrical Sub-Contractor for installation and wiring.
   d. Steam-to-hot water heat exchangers.
   e. Condensate return duplex pumps.
   f. Steam specialties such as traps, strainers, safety valves, flash tanks, meter, etc.
   g. Hot water specialties such as expansion tanks, air vents, air separators, reducing and safety valves, etc.
   h. Accessories such as flow measuring devices, machinery guards, thermostats, pressure gauges, etc.
   i. Water treatment for hot water system.
   j. Piping, fittings, and valves.
   k. Sheet metal ductwork and accessories such as access doors, etc.
   l. Pipe and equipment insulation.
   m. Temperature Control: A complete electronic system of temperature control shall be installed in connection with the HVAC systems, including all thermostats and valves. All control wiring for automatic temperature controls, including interlocking wiring for pumps, etc. by this Contractor.
   n. Painting and pipe identification for all work by this Contractor is previously specified under "Special Requirements for Mechanical and Electrical Work".
   o. Sleeves, pipe inserts and anchor bolts, escutcheons, etc., as hereinafter specified.
   p. Identification, name plates, tags and charts.
   q. Cutting and rough patching.

r. Furnishing and setting of electric motors.
s. Furnishing of starters, and motor control devices as specified under "Special Requirements for Mechanical and Electrical Work".
t. Templates and anchor bolts for equipment bases.
u. Removal, relocation and/or demolition of existing HVAC work in conjunction with the existing buildings in order to complete the work as indicated on the Contract Drawings.
v. Concrete pads for all HVAC work.

1.03 WORK INCLUDED UNDER OTHER SECTIONS OF THE SPECIFICATIONS

A. The following work is included under other Sections of the Specifications:
1. Valved water supply outlets within 5'-0" of the various pieces of the HVAC equipment will be left by the Plumbing Sub-Contractor. Final connections to HVAC equipment shall be made by this work.
2. Floor and funnel drains adjacent to equipment requiring same will be furnished and installed by the Plumbing Sub-Contractor.
3. Power wiring for all motors except where otherwise noted.
4. Temporary heat.
5. Setting of access doors furnished by this work.
6. All motor disconnect switches, except where in combination starters and where otherwise noted.
7. Finish painting.
8. Installation of access doors in ceiling and walls.
9. Finish patching.
10. Mounting of all starters, motor control centers, starter panelboards, and motor control devices: Division 16.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with quality established in Section 15000 "Special Requirements for Mechanical and Electrical Work", and hereinafter specified. All work performed shall comply with local codes.

1.05 SUBMITTALS

A. Submit shop drawings covering the following items:
1. Coordination drawings.
2. Duplex condensate pumps, including pump curves.
3. Internal cleaning of piping.
4. Identification schedule and samples.
5. Heat exchangers.
6. Expansion joints, anchors and guides, including details of installation.
7. Schedule of ductwork, joints, gauges, supports, access doors, etc.
8. Sheet metal fabrication drawings.
9. Schedule of steam traps.
10. Schedule of piping and fitting materials.
11. Piping shop drawings.
12. Schedule of valves, strainers, vacuum breakers.
13. Thermometers and pressure gauges.
14. Expansion tank.
15. Schedule of pipe and ductwork supports, including inserts, escutcheons, etc.
16. Heating systems, including cabinet heaters, fin tube radiation, etc., as specified.

17. Water pumps including pump curves.
18. All motor starters, motor control devices and motor control centers.
19. Water treatment equipment and systems.
20. Schedule of insulation types and samples of each type.
21. Air vents, air separators, water strainers, reducing and safety valves for water systems.
22. Automatic temperature controls.
23. Concrete pad location and size.

B. All shop drawings being submitted that include electrical work shall be submitted with all internal and external wiring diagrams.

C. The previously listed items are major equipment and do not limit this Division's responsibility to submit shop drawings for all equipment and accessories which are to be provided under this Division of the Specifications.

PART 2 - PRODUCTS

2.01 SPARE PARTS

A. Condensate return pumps and hot water pumps - For each pump listed, unless otherwise specified:
1. One set of wearing rings.
2. One set of bearings.
3. One set of packing glands complete with rings, nuts and bolts.
4. Three gaskets for casing joint.
5. Sufficient stuffing box packing for four packings.

Where pump specifications do not require packing glands of stuffing boxes, items #3 & 5 shall be omitted. Inline pumps w/stuffing box design, item #1 & 2 shall be omitted. Inline pumps w/standard mechanical seal spaces listed above except item #4 shall be omitted.

B. Spare Lamps:
1. Furnish ten (10) spare lamps for each size and type of lamp on instrument panels.

C. Miscellaneous Spare Parts:
1. Water column glasses shall be provided for each tank utilizing one.
2. One complete set of gaskets shall be provided for each of the following pieces of equipment:
   a. All manhole and handhole openings for the expansion tank and blow-down tank.
   b. Converters (oil and hot water).
3. Electrical equipment - two spare starter fuses identified for each type and size supply, return and exhaust fan and pump.
4. One set of bearings properly identified for each type and size supply, return and exhaust fan.
5. For each type and size pump furnished under this section of the contract, furnish as applicable for each type and size of pump, one set of wearing rings, one set of mechanical seals, one set of bearings, one set of shaft sleeves, one set of stuffing box bushings, one set of packing glands with rings, nuts and bolts and sufficient stuffing box packing for four packings.

2.02 LIST OF MANUFACTURERS

A. The manufacturer's name appearing first on this list is the manufacturer the project design was based upon. However, the additional manufacturers listed herein are also acceptable with the provision that they meet the requirements of these Specifications, ratings, and/or space allocations listed in the Specifications or shown on the Drawings.

1. Water Pumps (Base Mounted)
   a. Bell & Gossett
   b. Peerless
   c. Weiman
   d. Paco
   e. or approved equal
2. Condensate return Pumps
   a. Bell & Gossett
   b. Armstrong
   c. Thrush
   d. or approved equal
3. Heat Exchangers
   a. Bell and Gossett
   b. Alfa Lawal
   c. Taco
   d. approved equal
4. Cabinet Unit Heaters
   a. Vulcan
   b. Trane
   c. Rosemex
   d. Sterling
   e. or approved equal
5. Finned Tube Radiators
   a. Vulcan
   b. Trane
   c. Sterling
   d. or approved equal
6. Expansion Tanks
   a. Bell & Gossett
   b. Adamson
   c. Buffalo
   d. or approved equal
7. Water Specialties
   a. Bell & Gossett
   b. Taco
   c. or approved equal
8. Expansion Joints
   a. Zallea
   b. Flexonics
   c. or approved equal
9. Thermometers & Pressure Gauges
   a. Ashcroft
   b. U.S. Gauge
   c. Trerice
   d. Weiss Instruments
10. Motors
    a. General Electric

b. Westinghouse
c. Allis Chalmers
d. or approved equal

11. Starters, Motor Control Centers, Switches
    a. General Electric
    b. Westinghouse
    c. Cutler-Hammer
    d. or approved equal
12. Valves
    a. Jenkins
    b. Crane
    c. Walworth
    d. or as specified under paragraph on "Valves".
    e. or approved equal.
13. Insulation
    a. Owens-Corning Fiberglass Corp.
    b. CSG Snap-on
    c. Johns Manville
    d. or approved equal

PART 3 - EXECUTION (NOT USED)

END OF SECTION 15600

SECTION 15735

PUMPS FOR HVAC

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The Work includes providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, all pumps as shown on the Drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Manufacturing firms regularly engaged in manufacture of this equipment with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than ten (10) years

B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Provide equipment whose performance, under specified conditions, is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section, "Special Requirements for Mechanical and Electrical Work", and submit shop drawings.

1.05 COORDINATION

A. Refer to Section, "Special Requirements for Mechanical and Electrical Work".

1.06 GUARANTEE

A. Refer to Section, "Special Requirements for Mechanical and Electrical Work".

PART 2 - PRODUCTS

2.01 END SUCTION PUMPS

A. The casing and suction head of the pump shall be of cast iron material and end suction, vertical split type. Casing and suction head shall be equipped with 125# ANSI flanges. Pumps shall be assembled on heavy duty fabricated structural steel base plates, which bases

must include drip rim with tapped drain connections, which shall be piped to nearest floor drain. The impeller shall be of the enclosed type and shall be bronze. The impeller shall be statically and hydraulically balanced and keyed to the shaft. Efficiency and unit maximum BHP shall be quoted and guaranteed. Maximum head shall occur at and only at the no flow condition. The shaft shall be of steel material and removable shaft and shall be stainless steel. Bearings shall be single row, ball type and oil lubricated.

B. Pumps shall have replaceable case wear rings.

C. Stuffing box housing shall be deep enough to allow for a single John Crane type (1) mechanical seal. Each pump shall be flexibly coupled to a motor, Class B, DP enclosure. A flexible coupling with coupling guard shall be used. Except where otherwise noted, bearings shall be grease lubricated. Seals to be capable to withstand system condition for water temperature chemical treatment content as hereinafter specified under "Water Treatment". Provide John Crane cyclone separator to insure clear water flushing of the seal faces.

D. Pumps shall have capacities as scheduled on the Drawings. Pumps shall be selected to operate at or near their point of peak efficiency thus allowing for operation at capacities of approximately 25% beyond design capacity. In addition, the design impeller diameter shall be selected so that the design capacity of each pump (GPM and TDH) shall not exceed 90% of the capacity obtainable with maximum impeller diameter at the design speed for that model or as approved.

E. Casings shall be provided with suitable steel lifting lugs.

F. Pump shall be drawn down slightly on the foundation bolt nuts. Provide a form or dam around the contour of the bed plate. Pour grout through holes, provided for this purpose, in sufficient quantity to reach a level of :" to 1" above the bottom of the bed plate. Allow grouting to set thoroughly, then proceed with pipe connections.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where pumps are to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install equipment where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment comply with requirements and serve intended purposes.

B. Add concrete under structural members of pump base and grout around the base as required by manufacturer's written instruction.

C. Coordinate with other work as necessary to interfere installation of equipment with other components of systems.

D. Install all pumps with a minimum of five (5) pipe diameters of straight pipe upstream of pump suction connections or provide a suction diffuser. If the suction diffuser contains an integral strainer, the strainer required on the suction piping to the pump may be omitted.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirement. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactory corrected. Refer to Section Test and Balancing.

B. All pump casings shall be hydrostatically tested at 12" times design working pressure. The pump manufacturer shall be responsible for his service department aligning in the field prior to start-up of all flexibly coupled units. Alignment shall be with dial indicator with accuracy of plus or minus .002 inches. The pump manufacturer must submit a written report certifying that the alignment work had been performed by his personnel and that the pumps are ready for operation.

END OF SECTION 15735

SECTION 15736

DUPLEX CONDENSATE PUMPS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and made ready for operation by the Owner, all duplex condensate pumps as shown on the drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Manufacturing firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for a minimum of 10 years.

B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Provide equipment whose performance, under specified conditions, is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section - Special Requirements for Mechanical and Electrical Work and submit shop drawings.

1.05 COORDINATION

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

1.06 GUARANTEE

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

PART 2 - PRODUCTS

2.01 DUPLEX CONDENSATE PUMPS

A. Furnish and install where shown on Drawings, horizontal duplex condensate pumps, each consisting of two pumps, two motors, two starters with pilot lights and a single receiver per pump set. Units shall be as scheduled on the Drawings.

B. The condensate receiver shall be manufactured by cast iron or copper bearing steel over 70 gallons. The receiver shall be equipped with an externally adjustable mechanical alternators, water level gauge, dial thermometer, (2) pressure gauges for pump discharge.

C. A cast iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket shall be mounted in the inlet line to the receiver. The screen shall be easily removable for cleaning, requiring no additional space for servicing.

D. Pumps shall be close coupled vertical design, permanently aligned, bronze fitted and be equipped with stainless steel shaft, enclosed bronze impeller, renewable bronze case ring, and mechanical shaft seal. Each pump shall be close coupled to a vertical drip proof motor. Motor shall have 3500 RPM. Pumps shall be capable of handling 210EF water without cavitation.

E. The pump manufacturer shall furnish, mount on the pump unit, and wire a NEMA I sheet metal (plastic not approved) control cabinet with piano hinged door, containing:
1. 2 Combination magnetic starters (each having 3 overload relays) with circuit breakers and cover interlock.
2. 2 "Hand-Off-Automatic" selector switches.
3. 1 Numbered terminal strip
4. 1 Removable control mounting plate

F. Each pump control circuit shall be completely independent of the other. The mechanical alternator shall (1) change the operating sequence automatically after each cycle, (2) provide simultaneous operation under peak load conditions, and (3) operate the second pump automatically, should the active pump or its control fail.
1. A control circuit transformer for each circuit shall be provided when the motor voltage exceeds 250 volts. All factory installed wiring shall be numbered for easy identification and the numbers shall coincide with those shown on the wiring diagrams.
2. Pump manufacturer must verify that terminal head sizes are adequate for wire sizes specified.
3. The unit shall be factory tested as a complete unit. The pump manufacturer shall furnish complete elementary and connection wiring diagrams, piping diagrams, installation and operating instructions.
4. Duplex pumps shall be Type FPC Armstrong or Weinman Type ACV or EAV or approved equal.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install equipment where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of equipment with other components of systems.

C. Check alignment and, where necessary (and possible), realign shafts of motors and equipment within tolerances recommended by manufacturer.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, energized with normal power source, test equipment to demonstrate compliance with requirement. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected. Refer to Section - Testing and Balancing.

END OF SECTION 15736

SECTION 15740

HEAT EXCHANGERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and made ready for operation by the Owner, all steam to water heat exchangers as shown on the drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Manufacturing firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for a minimum of 10 years.

B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Provide equipment whose performance, under specified conditions, is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section - Special Requirements for Mechanical and Electrical Work and submit shop drawings.

1.05 COORDINATION

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

1.06 GUARANTEE

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

PART 2 - PRODUCTS

2.01 STEAM TO WATER HEAT EXCHANGERS

A. Furnish and install, where shown on the Drawings, a steam to water heat exchanger(s).

B. Type: Shell and tube, U-bend removable tube bundle, low pressure steam in shell, water in tubes.

C. Materials:
   1. Shell - steel
   2. Tubes - ⅝" O.D. copper
   3. Heads - Steel or cast iron
   4. Tube Sheets - Steel
   5. Tube Supports - Steel

D. Construction: A manufacturer's data report for unfired pressure vessels, form No. U-1, as required by the provisions of the ASME Code Rules, is to be furnished to the Architect. This form must be signed by a qualified inspector holding a National Board commission certifying that construction conforms to the latest ASME Code for Unfired Pressure Vessels for:
   1. 125 psig working pressures
   2. 240EF. temperature
   as detailed in form No. U-1. The ASME "U" symbol should also be stamped on the converter.

E. Fouling factor shall be 0.0005.

F. Capacity of heat exchanger shall be as scheduled on the Drawings.

G. Heat exchanger shall be Bell & Gossett, Patterson Kelley Yula, or approved equal.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. INSTALLATION

D. Install equipment where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment comply with requirements and serve intended purposes.

E. Coordinate with other work as necessary to interface installation of equipment with other components of systems.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, test equipment to demonstrate compliance with requirements. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected. Refer to Section - Testing and Balancing.

END OF SECTION 15740

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and made ready for operation by the Owner, all coils as shown on the drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Manufacturing firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for a minimum of 10 years.

B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Provide equipment whose performance, under specified conditions, is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section - Special Requirements for Mechanical and Electrical Work and submit shop drawings.

1.05 COORDINATION

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

1.06 GUARANTEE

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

PART 2 - PRODUCTS

2.01 WATER COILS

A. All water coils shall be of the continuous flat plate fin type for minimum resistance to air flow. Fins shall be fabricated with drawn collars and shall be bonded to the tubes by a hydraulic expansion process. Openings in unit casing for coil connections to be sealed against leakage. Coil casings shall be not less than 16 gauge galvanized steel.

B. Water coils shall be of the continuous tube type and circuited so as to be completely drainable by gravity through the supply header. Headers and tubes are to be fabricated of seamless .024 inch thick wall copper tubing. Fins are to be .009 inch thick aluminum for heating coils and .005 inch thick copper for cooling coils. Supply and return headers shall be complete enclosed within the unit casing or external where called for on the drawing, and shall be equipped with steel nipples of extra length equipped with drain and vent plugs outside unit casing. Coils shall have capacities as called for and shall have the minimum number of rows as shown on the schedule.

C. Cooling coils shall have ARI Certification.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install coils where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that coils comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of coils with other components of systems.

C. Check alignment and, where necessary (and possible), realign shafts of motors and coils within tolerances recommended by manufacturer.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of coils, test coils to demonstrate compliance with requirement. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected. Refer to Section - Testing and Balancing.

END OF SECTION 15748

SECTION 15771

CABINET HEATERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and made ready for operation by the Owner, all cabinet heaters as shown on the drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Manufacturing firms regularly engaged in manufacture of this material with characteristics 6nd capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Provide equipment whose performance, under specified conditions, is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section - Special Requirements for Mechanical and Electrical Work and submit shop drawings.

1.05 COORDINATION

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

1.1 GUARANTEE

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

PART 2 - PRODUCTS

2.01 CABINET HEATERS

A. Furnish and install cabinet heaters of size, type and capacities as shown on the Drawing.

B. Basic unit shall include chassis, coil, fan board, fan wheel (s), housing(s), motor and insulation. Chassis is galvanized steel wrap-around structural frame with all edges flanged. Insulation is faced, heavy density glass fiber.

C. Vertical Cabinet Models:
   1. 16 gauge steel front panels and 18 gauge steel end and top panels have channel-formed edges around entire panel perimeters. Front panel insulated over entire coil section. Integral, stamped outlet grilles have 15E deflection from vertical. Stamped lattice discharge grilles on inverted airflow models. Access door on coil connection side of unit. Front panel removable without tools.

D. Vertical Recessed Models:
   1. 16 gauge steel, four-side overlap front panels, with "M"-shaped stiffener running entire panel length as standard. Integral, stamped inlet and outlet grilles have 15E downward deflection. Front panel insulated over entire coil section. Front camlocked access doors on right hand side of unit. Front panel removed with two screws.

E. Horizontal Cabinet Models:
   1. 18 gauge steel panels. Bottom and end panels have channel-formed edges around entire panel perimeter. Integral, stamped outlet grilles have 15E downward deflection. Stamped lattice inlet grilles. Bottom panel hinged at front and camlocked at back.

F. Horizontal Recessed Models:
   1. 18 gauge steel, removable, four-side overlap bottom panel adjustable d" with full length, piano-type hinge at back and camlocks at front.

G. Cabinet Finish:
   1. All cabinet parts cleaned, bonderized, phosphatized, and flow-coated with baked-on primer. Final finish of spray applied baked-on enamel in colors selected by Architect.

H. Water Coils:
   1. e" OD seamless copper tubes mechanically bonded to configured aluminum fins with continuous fins collars and sleeved coil and supports. Maximum working pressure 300 psig., factory burst test 450 psig (air), and leak test 300 psig (air under water). Supply and return connections on same side of units on all models and sizes.

I. Fans:
   1. Fan wheels centrifugal, forward-curved, double of non-corrosive, molded, fiberglass-reinforced thermo-plastic material on all units except electric heat and inverted airflow models which use aluminum. Fan housings of formed sheet metal on 200-600 cfm units. 800-1800 cfm units have end caps made of non-corrosive, molded, fiberglass-reinforced thermo-plastic material, and fan scrolls of galvanized steel.

J. Motors:
   1. All motors have integral thermal overload protection and start to 78% of rated voltage. Motors operate satisfactorily at 90% of rated voltage on all speed settings and at 10% over voltage without undue magnetic noise. All motors factory run tested assembled in unit prior to shipping.

K. Filters:

1. Removable from vertical cabinet models without removing from panel; from vertical recessed units by removing front panel; from horizontal units by pivoting hinged bottom panel. 1" woven glass filters.

L. Electrical Performance:
1. All cataloged models wired in accordance with National Electric Code. Underwriters Laboratories, Inc. listed. Provide on-off switch with thermal overload.

M. Control
1. Provide unit mounted factory wired four position three speed switch, with manual starter and return air thermostat. Thermostat shall cycle fan on and off.
2. Ceiling mounted units shall be supplied with thermostat for remote wall mounting. Thermostat for ceiling mounted units shall be mounted and wired by the electrical Contractor. Thermostat shall be rated for the fan motor voltage and amperage.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install equipment where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of equipment with other components of systems.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, energized with normal power source, test equipment to demonstrate compliance with requirements. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected. Refer to Section - Test and Balancing.

END OF SECTION 15771

SECTION 15774

FIN TUBE RADIATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and made ready for operation by the Owner, all fin tube radiation as shown on the drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Manufacturing firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for a minimum of 10 years.

B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Provide equipment whose performance, under specified conditions, is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section 15000 - Special Requirements for Mechanical and Electrical Work and submit shop drawings.

1.05 COORDINATION

A. Refer to Section 15000 - Special Requirements for Mechanical and Electrical Work.

1.06 GUARANTEE

A. Refer to Section 15000 - Special Requirements for Mechanical and Electrical Work.

PART 2 - PRODUCTS

2.01 FIN TUBE RADIATION AND ENCLOSURES

A. Provide finned tube radiation complete with enclosures of one piece back panel, one piece front panel, heating element, hangers and accessories.

B. Fin tube radiation shall be I.B.R. rated.

C. Enclosure front panel, one-piece #16 USSG Steel cabinet, with top outlet. Each enclosure front panel, rigidly braced by integral vertical channel braces in at least two locations. Each front panel shall extend to wall and be fastened to back panel at both top and bottom. Enclosures shall be finished with baked-on gray enamel primer and final baked enamel finish, color as selected by the Architect.

D. Back panel, one-piece construction #20 USSG steel, and shall provide continuous support at both top and bottom for rigid fastening of front panel. Back panel, pre-punched for fastening to wall and for attaching of heating element hangers.

E. Support brackets minimum 4'-0" on centers for heating element shall attach to back panel; vertically adjustable for pitch, and providing free longitudinal movement for expansion and contraction. Where pipe runs under enclosures they too shall be supported from back panel. No sheet metal screws or other fastening devices shall be visible when enclosure is installed below eye-level. Where two or more enclosure sections are joined end to end, rolled enclosure edges shall form neat butt joint without butt straps or other concealing devices. No unfinished metal edges shall be visible in the installed ensemble.

F. Heating elements, constructed of corrugated aluminum fins mechanically bonded to seamless copper tubing. They shall be provided with swagged ends to permit end to end jointing without coupling.

G. Where fin-tube radiation with expanded metal cover is used, it shall be same element as specified for enclosed fin-tube radiation.

H. Fin tube elements shall have a capacity as shown on the Drawings when supplied with hot water at 190EF. average water temperature. Elements shall be 13" IPS with saturated steam at 1 PSI. Copper elements shall be 13" copper tubing of 0.024" wall thickness, with 33" x 33" aluminum fins of 0.015. Thickness spaced 40 per foot. All elements shall be two rows high unless otherwise noted on the Drawings.

I. Provide end caps where radiation terminates at doors, walls, pilasters or columns and inside or outside corners where required.

J. Provide knob-operated dampers above all radiation where radiation. Provide access doors in encloses at balancing valves, shut-off valves and air vents.

K. All radiation enclosures and access door locations shall be field measured prior to fabrication.

L. Fin tube radiation shall be of type as scheduled on the drawings.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install equipment where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of equipment with other components of systems.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, test equipment to demonstrate compliance with requirements. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected. Refer to Section - Testing and Balancing.

END OF SECTION 15774

SECTION 15801

HVAC SPECIALTIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, all HVAC Specialties as shown on the Drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Firms regularly engaged in manufacturer of this equipment with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than ten (10) years.

B. Provide products produced by the manufacturers, which are listed in Section entitled "Approved Manufacturers List".

C. Provide equipment whose performance under specified conditions is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section entitled "Special Requirements" for mechanical and electrical work and submit shop drawings.

1.05 COORDINATION

A. Refer to Section "Special Requirements" for mechanical and electrical work.

1.06 GUARANTEE

A. Refer to Section "Special Requirements" for mechanical and electrical work.

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Furnish and install, where indicated on the Drawings and where specified herein, separable well-type dial or 9" mercury adjustable angle type in glass stem, thermometers as manufactured by American, Trerice, Weksler, Weiss or approved equal.

B. All thermometers shall be installed in such a manner as to cause a minimum of restriction to flow in the pipes and so that they can easily be read from the floor.

C. Dial thermometers shall be 5 inch hermetically sealed, bimetal with stainless steel cases, antiparallax dials with raised jet black figures, stainless steel stems, and brass separable sockets unless otherwise specified. Thermometers for duct mounting shall have union connections in lieu of separable sockets. Separable wells shall be stainless steel for steel pipe and brass for copper pipe. Separable wells shall be standard type for uninsulated pipe and logging extension type of proper length for insulated pipe. Stem shall extend a minimum of 2-1/2" into the fluid.

D. The accuracy of all thermometers shall be within 1% of the scale range.

E. All instrument wells for controls and indicators furnished by the temperature control manufacturer shall be installed under this Section.

F. Where conditions are such that thermometers would not be readable from the floor, remote bulb dial thermometers shall be mounted on panelboards. The thermometers shall be 5 inch dials and shall be vapor actuated. The thermometers shall have separable wells. Panel mounted thermometers shall be provided with an engraved nameplate mounted below each thermometer to identify its service. The nameplates shall be chrome plated with black filled letters.

G. A thermometer shall be installed in the water inlet and outlet of each heat exchanger and in and out of the cooling tower. Additional thermometers shall be installed where indicated on the Drawings.

H. The scale range for the thermometers shall be as follows:

Service	Temperature Range	Remarks
Closed Loop Condenser Water	0^{o} to 120°F	
Chilled Water	0^{o} to 120^{o} F	
Cooling Tower Water	0° to 120° F	

2.02 PRESSURE GAUGES

A. Furnish and install where indicated on the Drawings and where specified herein, Bourdon spring type pressure gauges as manufactured by U.S. Gauge, Weksler, Trerice, Marsh, Ashcroft, or approved equal.

B. All gauges shall be installed so as to be easily readable from the floor. Where conditions are such that gauges on piping would not be readable from the floor, the gauges shall be installed on panelboards.

C. The gauges shall have dull, black enamel cast aluminum casings with chrome plated bezels or rims. The gauges shall have white faces with black filled engraved numerals and adjustable pointer. The diameter of the dial shall be not less than 4-1/2 inches. Gauges shall have brass bronzed brushed rotary type movement.

D. Panel mounted gauges shall be designed for flush mounting with back connections and shall be provided with an engraved nameplate mounted below each gauge to identify its service. The nameplates shall be chrome plated with black filled letters.

E. Differential pressure switches, pressure sensing pipe taps, furnished by temperature control manufacturers shall be installed under this Section.

F. The accuracy of all gauges shall be within 1% of the scale range.

G. All gauges on water lines shall be fitted with filter type pressure snubbers consisting of 3/8" dia. x 1/8" thick, micro metallic stainless steel filter, as manufactured by Operating and Maintenance Specialties or approved equal. All gauges on steam lines shall be fitted with pigtails.

H. A pressure gauge shall be installed in the suction and discharge of each pump. A pressure gauge shall be installed in the inlet and outlet of each heat exchanger. Additional pressure gauges shall be installed where indicated on the Drawings.

I. The scale range of pressure gauges shall be 0 to 125 PSIG.

J. A ball valve shall be installed on the water side of each gauge. A needle valve shall be installed on the system side of each steam gauge.

2.03 MACHINERY GUARDS

A. Moving parts of machinery exposed to contact by personnel shall be guarded by barrier to a type which complies with OSHA Code.

B. Exposed moving parts such as belts and couplings shall have not less than 3/4" No. 16 gauge metal guards with all edges rounded and gauge, material and construction shall be in accordance with OSHA standards - paragraphs 7173.3, 7173.5 and 7174.1. Guards shall have 1-1/4" x 1-1/4" x 1/8" angle iron frame properly supported.

C. All machinery guards covering the ends of motor or equipment shafts shall have openings for the insertion of a tachometer. Machinery guards shall be painted with two coats of machinery gray enamel.

2.04 BALANCING AND SHUT-OFF VALVES

A. Furnish and install balancing and shut-off valves at the locations shown on the plans and as required to balance the water systems. Valves shall be Tour and Anderson or approved equal.

B. Units shall be bronze balancing valves with a maximum rated working pressure of 175 psig at 250^{o}F. The balancing valve shall be a bubble tight shut-off valve suitable for use as a shut-off valve, constructed of a brass ball and Teflon seat to prevent leakage. Valves shall not require disassembly prior to installation. The valve shall be furnished with provisions for connecting a portable differential pressure meter for use in determining fluid flow and an integral indicator shall register the degree of valve opening.

C. Each valve shall be supplied with a polyurethane foam insulation jacket for installation around the valve after setting and balancing. Units in 2“ and 3/4" sizes shall have threaded connections, units 1" thru 3" shall have threaded connections.

D. Units 4" and larger shall be cast iron lubricated plug valves with flanged connections.

E. A portable differential pressure meter model 788 and balancing slide rule shall be furnished and used to present and adjust the valves for the flow as specified on the plans. The meter shall be furnished with all necessary hoses, valves and carrying case.

2.05 EXPANSION TANKS

A. Furnish and install expansion tank(s) of the size and type as shown on the plans. Tanks shall be Amtrol, Ex-Trol full diaphragm type or approved equal. Tank shall be furnished with ASME stamp and certification papers.

B. Furnish and install as shown on the Drawings, EX-TROL Pressurized Diagram Type Expansion Tanks as manufactured by AMTROL INC. It shall be air precharged to the initial fill pressure of the system. It shall be suitable for a maximum working pressure of 125 psi and shall be furnished with ASME stamp and certification papers. It shall have a sealed-in elastomer diaphragm suitable for an operating temperature of 240E F. (EX-TROL to be furnished with saddles for horizontal installation).

2.06 EXPANSION JOINTS, BALL JOINTS, LOOPS, ANCHORS AND GUIDES

A. Provisions for expansion in piping mains, branches, and risers shall be made by the installation of offsets, expansion loops, or compensators as indicated on the Drawings and as required. Every 100'-0" horizontal steam piping shall have expansion loop and anchors. Minimum loop shall be 8'-0" by 6'-0" if not indicated on the Drawings.

B. All piping with loops or compensators shall be anchored so as to throw all expansion toward the loops or compensators.

C. Guides shall be installed on both sides of each expansion loop and compensator. Guides shall be Flexonics pipe alignment guides or approved equal. Anchors and guides shall be secured to beams, columns or concrete slabs.

D. Pipe hangers and rollers are not considered guides.

E. Provide 12" long guides for each expansion joint. Guides shall be located 3'-0" on each side of the expansion joints.

F. Furnish and install as shown on plans, or where necessary to absorb max. 1-3/4" expansion and max. 1/4" contraction between two anchor points in iron and steel pipe lines up to and including 2-1/2", Flexonics Model II Expansion Compensators having two-ply stainless steel belows and carbon steel shrouds and end fittings, as manufactured by Flexonics Division of Calumet & Heela, Inc., Bartlett, Illinois. Service pressure shall be external to the bellows. Compensators shall have properly located positioning clip to insure installation at correct end-to-end dimension to allow full rated traverse. Compensator shall be for Max. 150 psig. working pressure. Test pressure shall not exceed 200 psig.

G. Expansion joints in 3" and above piping shall be hydraulically formed bellows type with internal sleeves and external covers for insulation. Expansion joints, except where otherwise noted, shall be of the self-equalizing type having fully-contoured, cast iron equalizing rings.

H. Provide non-equalizing type expansion joints with internal sleeves on low pressure service (up to 15 psig including test pressure) and self-equalizing expansion joints on service where pressure exceed 15 psig (including test pressure up to 300 psig).

I. Manufacturer shall note on all submittal forms the resultant anchor loads due to pressure thrust and compressive forces at design conditions. Expansion joints shall be as manufactured by Flexonic, Keflex, or approved equal.

2.07 DRAFT GAUGES

A. Furnish and install at each filter, draft gauges for measuring the resistance of the air through the filters.

B. Each draft gauge shall be an inclined tube differential type for indoor units, equipped with a shut-off cock opening to atmosphere for checking zero setting, and with a shut-off cock in the lines to points where the draft is measured. The scale shall have a white background with heavy black divisions and figures; shall not be less than 8" long, and shall be graduated to read by hundredths of an inch up to resistances to be encountered. Each gauge shall be provided with a bubble level gauge and with screw adjustment for zero settings.

C. Draft gauge for rooftop units and outdoor unite shall be 2000 Series Magnehelic as made by Dwyer or approved equal. Gauges shall be provided complete with two static pressure tips case, fittings and means of mounting. Scale shall be as required. Set gauges to be easily readable from floor level. Gauges shall be of Dwyer make or approved equal.

2.08 AIR VENTS

A. In installing water piping systems and all equipment, carefully plan the actual installation in such a manner that high pints and air pockets are kept to a minimum and are properly vented where they are unavoidable. All air elimination devices called for on the Drawings and in these Specifications shall be provided and properly installed. In addition, furnish and install all other air elimination devices which may be required due to job conditions. Assume responsibility for a proper, continuous and automatic air elimination to assure even and balanced distribution of water to all equipment.

B. Furnish and install an Armstrong No. 1 AV or Sarco 13W automatic air vent with test petcock at each high point in the water piping mains and where indicated on the Drawings. Furnish and install a 125 psig rated valve on the system side of each automatic air vent. Vents on water lines shall have Hoke Fig. No. PY-271 valves or approved equal.

C. Furnish and install manual air vents Hoffman No. 500 or approved equal, for all upfed radiation. Furnish and install a 125 psig rated ball valve on the system side of each manual air vent. Provide access to all air vents.

2.09 AIR SEPARATORS

A. Furnish and install the air separators for water system where indicated on the Drawings. The separators shall be Rolairtrol, as manufactured by Bell and Gossett or equal as approved by the Architect.

B. The units shall be of ASME construction and shall be stamped 125 psig W.P.

C. The units shall be furnished without integral strainers.

D. The units shall be installed in strict accordance with the manufacturer's recommendations.

E. The units shall be supported on 2" pipe legs and shall be provided with a 3/4" drain gate or ball valve with hose end and cap.

2.10 STRAINERS FOR WATER SYSTEM

A. Furnish and install a full size Y-pattern strainer on the inlet of each control valve and each water pump, where indicated on the Drawings.

B. The strainers shall be as manufactured by Spence, Sarco, Barnes and Jones, Elliott, Crane or Mueller.

C. All strainers, except where otherwise noted, shall have bronze body up to 2-1/2", semi-steel above 2½", rated at 125 psig for all systems with 50 psig max. pressure and 250 psig for all others. Strainers 2 inch diameter and smaller shall have screwed ends. Strainers 2-1/2 inch diameter and larger shall have flanged ends.

D. All strainers shall have removable cylindrical or conical screens of brass construction. They shall be designed to allow blowing out of accumulated sediment and to facilitate removal and replacement of the screen without disconnecting the main piping.

E. Screens for water 1/16" for 3" inclusive, 1/8" for 4" and above.

F. An approved blow-out connection with gate valve shall be made to each strainer. The valves shall be located not higher than 8 feet above the floor. All drain connections shall be piped to floor drains.

2.11 REDUCING AND SAFETY VALVES FOR WATER SYSTEM

A. Furnish and install pressure reducing and safety valves for makeup water systems and where indicated on the drawings.

B. The reducing valve shall be Model 7 pressure reducing valve with field adjustable setting as manufactured by Bell & Gossett or equal as approved by the Architect.

C. The safety valves shall be of size and capacity as indicated on the Drawings. The valves shall be made by Bell and Gossett or approved equal and shall have 150 pound raised face flange on the inlet and discharge for all sizes 2-1/2" and above 2" and below shall be screwed.

D. The safety valves shall be steel valves with stainless steel trim. The bonnet shall be enclosed and equipped with a packed lifting lever. The spring shall be carbon steel rated for 450^{o} F.

E. The vertical discharge line from the safety valves shall be installed as close to the safety valves as possible and piped to drain.

PART 3 - EXECUTION

A. INSPECTION

1. Contractor shall examine location where these specialties are to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install HVAC Specialties where shown, in accordance with manufacturer's written instructions and with recognized industry practices, to ensure that HVAC Specialties comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of HVAC Specialties with other components of systems.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of HVAC Specialties, test HVAC Specialties to demonstrate compliance with requirements. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

END OF SECTION 15801

SECTION 15802

STEAM SPECIALTIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and made ready for operation by the Owner, all steam specialties as shown on the drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Provide equipment whose performance, under specified conditions, is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section - Special Requirements for Mechanical and Electrical Work and submit shop drawings.

1.05 COORDINATION

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

1.06 GUARANTEE

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

PART 2 - PRODUCTS

2.01 STEAM TRAPS

A. Furnish and install steam traps of approved types and capacities for proper venting and draining of all piping and of all pieces of equipment, including traps required at all ends of

mains, heels of risers, and any other point where condensate and/or air may collect, such as ahead of pressure and temperature regulating valves, lifts and drops in steam mains, etc.

B. All traps shall be designed for the steam pressure and service for which they are to be used and shall pass all condensate and air automatically, without passing any steam. Traps shall be of the types as specified hereafter, as may be required for satisfactory operation. All steam traps shall be warranted to have been tested in the manufacturer's plant under steam to insure tight closure and satisfactory operation.

C. All steam traps shall be sized for a minimum capacity of 300% of the steam loads indicted on the drawings, and at a maximum pressure drop of 2 psi for low pressure systems and 2 psi for medium pressure systems and 5 psi for high pressure systems, when continuously handling air and condensate. Ratings shall be in accordance with the standards of the Steam Heating Equipment Manufacturers Association.

D. Traps for heat exchangers shall be sized for 400% steam capacity.

E. It shall be this Contractor's responsibility to install the entire system of return line piping so that all condensate will be returned without water hammer.

F. Each heating unit, regardless of type, shall be installed with shut-off valve at inlet. Each radiator or convector shall have at its supply inlet, a bronze body valve of packless quick-opening type which shall pass sufficient steam when fully opened to fully heat the radiator surface with the lowest pressure carried in the mains.

G. The following schedule of trap types shall apply:

Schedule of Steam Trap Types
Sarco as Standard

Drips for Low Pressure mains and risers	FT
Drips for Low Pressure risers under 2 inches	FT
Radiators, convectors, fin-tube radiators	T
Heating equipment requiring temperature control	FT
Hot water heaters	FT
Tank heaters	FT
Unit heaters	FT
Flash Tank Discharge	F
Heat Exchangers	FT

CODE:

FT - Float and Thermostatic Trap
B - Inverted Bucket Trap
T - Thermostatic Trap
F - Float traps without thermostatic vent

H. All traps up to and including 2-2" size shall be provided with threaded connections. Traps over 2-2" size shall be provided with welded flanged connection.

I. Traps 1" size or less shall be provided with union connections.

2.02 THERMOSTATIC STEAM TRAPS

A. Traps shall be Sarco or approved equal. Thermostatic traps shall be of the corrugated-bellows, balanced pressure type, with a bellows made of high grade red brass or phosphor bronze. Regardless of working pressure traps shall have a minimum working pressure of 125 psi. All steam traps to be sized on condensate at steam temperature.

B. The bellows shall be either of Phosphor Bronze (with high temperature solder and brass sleeve protection) or Monel metal, properly brazed.

C. Low pressure (0-25 psi) thermostatic traps shall have cast brass or forged brass bodies suitable for 125 psi pressure and shall be provided with a union connection at the inlet. Self-aligning valve heads and seats for the low pressure traps shall be of a suitable, non-corrosive material. Seats shall be removable. Sarco type H or other approved equal shall be acceptable.

D. Valve heads and seats for medium pressure (0-65 psi) traps shall be removable and shall be of stainless steel. The solder used for the bellows shall be suitable for the higher temperature of medium pressure steam. Sarco type S-65 or other approved equal shall be acceptable.

2.03 COMBINATION FLOAT AND THERMOSTATIC STEAM TRAPS

A. Combination float and thermostatic traps shall have a valve mechanism, the position of which is controlled by a closed, stainless steel ball float. The seat of the valve will be watertight at all times. The action of this type of trap must be gradual and modulating, it must discharge the condensate as soon as it enters the trap and its rate of discharge must be proportionate to the rate of the flow of condensate to the trap. A gate valve and strainer shall be installed ahead of all float and thermostatic traps.

B. The traps shall be provided with an automatic, thermostatic air bypass of the balanced pressure, multiple bellows type.

C. All working parts shall be of non-corrosive metal (hard bronze, monel or stainless steel) and shall be removable without disconnecting the piping. Floats shall be of stainless steel.

D. Body and cover shall be of high grade cast iron suitable for 125 psi pressure for the 0-15 psi line. Traps shall be Sarco FT-15 or approved equal.

E. 0-30 psi traps - all bodies and covers shall be designed for 125 psi steam pressure.

2.04 HIGH CAPACITY FLOAT TRAPS

A. For high capacity, float traps with double ported, closely balanced stainless steel valves shall be used. These traps shall not require change of seat size with varying pressures. Thermostatic air vents shall be located on outside of trap body. Provide Sarco FT-20 or approved equal.

2.05 INVERTED BUCKET TRAPS

A. Inverted bucket traps for pressures from 1 to 250 psig, shall have semi-steel body; valve and valve mechanism are to be of stainless steel and shall be of "camlift action" for extra capacity. Up to 75 psi traps shall have 125 psi rating. Above 75 psi the rating shall be 250 psi.

B. An open inverted bucket with a vent-hole in its top shall activate the valve mechanism.

C. Inverted bucket shall be either of brass or of stainless steel.

D. Traps shall have bi-metallic vent. All traps shall be equipped with built-in removable strainer. Same is to be of perforated sheet brass or stainless steel. Traps to be "Sarco Type B" or approved equal and shall be designed as follows:

SIZE	WITH BIMETAL AIR VENT
1-2" or :"	B12-X
:"	B22
1"	B32
1-3"	B42
2"	B52

2.06 STRAINERS FOR STEAM AND CONDENSATE

A. There shall be approved strainers in the inlet connections to each coil, steam trap, and each diaphragm valve, and where ever indicated on the drawings. The intention is to protect by strainers, all apparatus of an automatic character, whose proper functioning would be interfered with by dirt on the seat, or by scoring of the seat.

B. All strainers in steam lines, shall be Y-pattern, set in a horizontal (or vertical downward) run of the pipe. Where this is not feasible, strainers may be of enlarged-cross-section type. Strainers shall be so arranged as not to "trap" pipes, and to facilitate disconnection and opening-up for cleaning. Unless otherwise indicated, strainers shall be line size.

C. All strainers, 2-2" and above, shall have cast iron bodies and 2" and below shall have bronze bodies of ample strength for the pressure to which they shall be subjected, removable cylindrical or conical screens of monel or stainless steel and suitable flanges or tappings to connect with the piping they serve. They shall be of such a design as to allow blowing out of accumulated dirt, and to facilitate removal and replacement of a strainer screen, without disconnections of the main piping.

D. Strainer screen perforations shall be 1/32" for steam and mixture of steam and condensate. Strainers of the"Y" type similar to Sarco Bulletin 1220 type IF and AF or approved equal. Strainers smaller than 2" shall be Sarco type "BT".

E. Provide approved valved dirt blow-out connections for each strainer (with the valve located 6" to 1'-0" below strainer, or as directed). The blow-out connection shall terminate with a valve, nipple and cap. Blowoff shall be 4 pipe sizes smaller than straight pipe :" minimum size and shall be suitable for a hose connection with cap.

F. All strainers shall be provided with flanged covers for screen removal in lieu of screwed covers wherever obtainable.

G. All strainer screens 8" and above shall be reinforced for the operating conditions.

2.07 EXPANSION JOINTS

A. All piping shall be installed in such a manner as to allow for thermal expansion and contraction without strain to connections at equipment or interconnections piping. While it is preferred that pipe flexibility be utilized to the greatest extent, either through directional

changes or pipe loops, expansion joints shall be installed where shown on the plans and shall comply with the following requirements:

B. Expansion joints in 3" size and over shall be of the stainless steel bellows type, being hydraulically formed from a tube having only longitudinal seam welds. The weld bead of the seam shall be of the same thickness as the parent metal without grinding to avoid areas of stress concentration.

C. Expansion joints shall be flanged with drilling to meet 150 lb. ASS standards except where so noted. All components shall be suitable for 150 psig service and the traverse indicated on the plans or schedule.

D. Expansion joints shall be of the self-equalizing type, being furnished with equalizing rings designed to distribute the movement equally among the corrugations while supporting the roots and side walls of the corrugated element against internal pressure. The end reinforcing skirt flange assembly shall be made entirely of steel and welded into one integral unit. Acceptable manufacturers: Zallea Brothers, ADSCO and Flexonics Division of Calumet & Hella, Inc.

E. Expansion joints in sizes 2-2" or less than be of the "Compensator" type and suitable for 1-:" compression plus 3" extension while at 150 psig internal pressure. Compensators shall be internally guided by a positive anti-torque device to prevent twisting on installation. For all high pressure system and expansion joints on main and branch piping compensation shall be Zallea Series H. Expansion joint on radiation shall be Zallea Series L. Acceptable manufacturers: Zallea Brothers, Flexonics.

F. All piping shall be properly anchored and guided in accordance with the Standards of the Expansion Joint Manufacturers Association. The Contractor shall furnish drawings showing proposed expansion joint, anchor and pipe guide locations as well as details of construction of such piping system components not otherwise shown on plans and specifications.

2.08 MOISTURE SEPARATORS

A. Furnish and install the moisture separator for steam system where indicated on the Drawings. The separator shall be 6” ANSI 150 Model S4A, as manufactured by Spirax Sarco or approved equal.

B. The units shall be of ASME construction and shallbe stamped 150 psig.

C. The units shall be installed in strict accordance with the manufacturer’s recommendations.

D. The units shall be supported individually from piping by at least two hangers with vibration isolators.

2.09 SATURATED STEAM FLOW METER:

1. Manufacturer "SPIRAX SARCO", model: 3" ANSI-600, S4A.
2. 1.5" ANSI-150, S-PhD inline vortex;
3. capacity at 10 PSI: 77 LBS/HR TO 697 LBS/HR.
4. pressure transmitter S-PT.
5. flow processor S-FP-93

Warranty: The equipment shall be guaranteed to be free from defects in material and workmanship for a period of fifteen (15) months after shipment or twelve (12) from date of installation, whichever period shall first expire. All wiring and controls under this contract.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where steam specialties are to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install steam specialties where shown, in accordance with manufacturer's written instructions and with recognized industry practices, to ensure that equipment comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of steam specialties with other components.

END OF SECTION 15802

SECTION 15815

WATER TREATMENT AND CLEANING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, all water treatment and cleaning as shown on the drawings and hereinafter specified.

B. The Contractor shall engage the services of a water treatment contractor who shall provide a complete water treatment service during construction and for a period of one year following Owner’s acceptance of the system. The service shall include furnishing and application of all chemicals, at least one visit a month to collect samples for chemical analysis at the water treatment company's laboratory, and all necessary inspection, adjustment, and maintenance of the chemical treating devices. Complete chemical control of the treatment shall be included. Reports shall be furnished to Architect after each visit.

C. Water treatment shall be applied concurrently with the operation of each circulating water system for a period of one year. An initial dose of treatment chemical shall also be applied immediately after each system is initially filled with water if operation is to be delayed after filling.

D. In addition to the chemicals indicated, slimicides and algaecides shall be provided as necessary. Chromate and phosphate will not be acceptable. All chemicals shall be approved by local and state agencies having jurisdiction for discharge to the sewer system.

E. The firm's water treatment laboratory shall be equipped to analyze water in accordance with the statement methods of the American Public Health Association.

F. Water treatment contractor shall provide chemical feeding devices during the period of this contract. At the termination of the contract, the treatment equipment shall belong to the Owner.

G. Provide a water treatment program for hot water closed heating systems.

1.03 QUALITY ASSURANCE

A. Firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Provide equipment whose performance, under specified conditions, is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section - Special Requirements for Mechanical and Electrical Work and submit shop drawings.

B. Submit documentation of acceptability of chemicals for discharge to the sewer system.

1.05 COORDINATION

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

1.06 GUARANTEE

A. Refer to Section - Special Requirements for Mechanical and Electrical Work.

PART 2 - PRODUCTS

2.01 CHEMICAL TREATMENT CLOSED HOT WATER SYSTEMS

A. Provide a Nitrite based material to maintain the following conditions in each closed water system.

pH	7.5 - 9.0
Nitrite as NO_2	1500 - 2000 ppm

2.02 CHEMICAL TREATMENT - CLEANING - DEGREASING

A. Provide a supervised program of cleaning and degreasing chemicals used in the specified systems prior to start-up. Sufficient chemicals shall be added to each system to establish a concentration of 120 ppm degreasing chemicals containing 20% dioctysulfocuccinate and a concentration of 240 ppm of cleaning chemical containing 15% polyacrilate and 25% diphosphonate in the water. Systems shall then be circulated for a minimum of 8 hours, dumped, flushed, and refilled, with the correct corrosion inhibitors added for operation. Strainers are to be hand cleaned after flushing.

2.03 PIPE CLEANING

A. Furnish all required pipe cleaning chemicals, chemical feed equipment, materials, and labor necessary to clean the existing piping as herein specified. In addition, permanently install necessary chemical injection fittings complete with stop valves, etc.

B. Use chemical that, when used in accordance with the procedure, is not injurious to persons, piping, pipe joint compounds, packing, coils, valves, pumps and their mechanical seals, tubes or other parts of the system.

C. Use the water treatment suppliers labor only, with supervision from mechanical contractor.

D. Furnish instructions dictating the quantities of the cleaner and inhibitor to use, methods and duration of the operation.

E. Install temporary electrical connections if supplemental cleaning apparatus as necessary.

2.04 WATER TREATMENT CHEMICALS

A. Provide, from start-up, operation during construction and one-year's supply of necessary water treatment chemicals including the following.

2.05 CHEMICAL FEED EQUIPMENT - CLOSED CHILLED AND CONDENSER SYSTEMS

A. Provide a 5 gallon shot feeder including funnel, relief valve and air vent for intermittent feed of corrosion inhibitor across a suitable pressure drop in each closed system.

2.06 WATER TREATMENT CONTROL TESTING EQUIPMENT

A. Provide a test set complete with apparatus and chemical regents for the determination of phosphonate (ortho), ph (7.6 - 9.2), nitrite and any additional test as required by water treatment company.

2.07 CLEANING OF PIPING SYSTEMS (NEW AND EXISTING TO REMAIN AND BE USED)

A. Preliminary Cleaning:
   1. Clean piping internally by flushing prior to the application of pressure tests and before the chemical cleanout procedures specified herein. Provide temporary strainers at the inlet to the chilled water and condenser water pumps before the start of cleaning procedures.
   2. Block off and isolate circulating pumps, cooling coils, heating coils and steam traps during the preliminary flushing and draining process.
   3. Thoroughly flush piping clear of foreign matter with City water under pressure, and then drain before proceeding with pressure testing. Blow down accumulations of grit, dirt and sediment at each strainer and each low point in the piping systems.
   4. Provide bypass flush valves and required piping to permit full circulation of water during the washout of the piping systems. Close shutoff and balancing valves on branch piping to the terminal equipment units during the washout operation to prevent water circulation through the automatic control valves.

B. Chemical Cleanout:
   1. After completion of pressure testing, chemically clean internally each recirculating water system (including chilled water, and condenser water).
   2. Provide temporary connections with valves to fill the piping and remaining equipment with water for the purpose of draining piping and equipment after completion of the chemical cleanout procedure. Provide temporary blind flanges and/or caps to isolate the piping and equipment noted herein.
   3. Provide temporary piping connections, valves, strainers, bypasses, and blank connections where required to clean out systems. Line each strainer basket with a fine mesh nylon screen and replace the screens at the end of each day's circulation until each system is thoroughly cleaned.

C. Fill each system with City water; start circulation pump and vent high points manually until all air is released from the system.

1. All new recirculating water systems, both open and closed, to be filled and flushed with a solution of a non-foaming chemical detergent, to remove all foreign matter. Circulate the solution for a minimum of 8 hours and drain as rapidly as possible to remove suspended matter. Flush the system with fresh water, drain a second time and refill. After final filling, the pH of the water must not exceed the pH of the fresh incoming water by more than 0.5 pH.
2. Introduce the chemical solution into the system gradually by injecting into the suction side of the circulating pump, or by means of a bypass chemical. For the closed loop condenser water system slowly raise and then maintain the temperature of the circulating water at 150.F. by circulating through the hot water converter.
3. While the water is being heated (closed loop CW system) and circulated, open each drain connection for a short flow. Repeat at hourly intervals. Replace any water drained during blowdown with chemical solution as required until air is eliminated from the system. The chemical cleanout procedure to be continuous in this manner for 2 full 8-hour periods.
4. At the conclusion of the chemical cleanout period, completely drain the entire system and allow to cool. Flush out with fresh City water prior to final activation of the system. Remove temporary equipment and strainers, reconnect permanent pump and replace items previously removed.

D. Steam Systems:
1. Clean steam and condensate piping by sending steam through the piping for a period of not less than 16 hours. Isolate and bypass steam traps. Mix the condensate with cold water in a barrel or container so that the temperature of the mixture does not exceed 120^{o}F. and discharge to the sewer.
2.

E. Filling of Water Systems:
1. After completion of the chemical cleanout, fill each water system with fresh water, air vent, and add chemical treatment.
2. If the outdoor ambient temperature drops to 32^{o}F., and the danger of freeze-up exists, drain water systems.

2.08 INTERNAL TREATING OF PIPING

A. This work shall include the internal protective coating of all distribution systems on this construction such as, but not limited to, steam piping, hot water heating and cooling, chilled water and condenser water systems and components.

B. This method of treating is to be applied to all piping supply and return and then back to the source of equipment.

C. The Contractor shall clean the piping for the purpose of removing lime, oil, grease, oxides and other wastes therefrom. After the removal of these impurities, a protective coating shall be applied to all inner surfaces, which will inhibit oxidation as well as protect the metals against impurities that may be present in the water. This coating shall be guaranteed for five years from date of completion at no cost to the Owner, covering labor and materials. Valve-off heat exchangers to avoid coating surfaces.

D. The treating materials use for this purpose must have been in use successfully for at least five years in comparable systems.

E. It shall be compounded of non-corrosive, non-toxic, non-alkaline and non-injurious ingredients that have been investigated and reported as a "Neutral Compound" by a

recognized engineering firm or laboratory, other than the submitting company's own laboratory. Brochures and unbiased test reports shall be submitted to the Architects within 90 days from job acceptance for approval. This treating firm shall show proof, that said firm has been established and accepted for this work, for a minimum of 10 years. The ingredients used shall have no deleterious effects on seals, O-rings, glands, packing, etc.

F. It shall be the sole responsibility of the approved firm for the application of this process. He shall supply all labor, materials, and equipment for this purpose. A competent supervisor and/or equipment operator shall be kept at the site from commencement of his work until completion. None but experienced men shall provide treating of piping. Any repairs or servicing of components of these systems shall be done by the Contractor.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install water treatment equipment where shown or specified, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that water treatment systems comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of water treatment equipment with other components of systems.

C. Check alignment and, where necessary (and possible), realign shafts of motors and equipment within tolerances recommended by manufacturer.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, and after motors have been energized with normal power source, test equipment to demonstrate compliance with requirements. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

END OF SECTION 15815

SECTION 15820

PIPING FOR HVAC

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The Work includes providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, all piping as shown on the Drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. "Manufacturers"-Firms regularly engaged in manufacture of pipe whose products have been in satisfactory use in similar service for not less than ten (10) years.

B. Provide pipe whose performance, under specified conditions, is certified by the manufacturer.

C. Piping systems and installation of piping shall comply with ANSI/ASME B31.9, Building Service Piping (B31.1, Power Piping).

D. All piping shall be made in the USA and shall be labeled as such. Piping shall also be labeled with ASTM number for easy identification/verification at the site.

1.04 SUBMITTALS

A. Refer to Section 15000, "Special Requirements for Mechanical and Electrical Work", and submit shop drawings.

B. Submit pressure-temperature ratings for all fittings.

1.05 COORDINATION

A. Refer to Section 15000, "Special Requirements for Mechanical and Electrical Work".

B. Furnish fabrication detail drawings for all pipe hangers and supports for piping 22 inches nominal size and larger.

C. Furnish hanger and support location drawings for piping 22 inches nominal size and larger.

D. Perform calculations necessary for the design and selection of hangers, supports, anchors, guides, restraints, snubbers, and supplementary supporting steel for piping 22 inches nominal size and larger.

E. Perform weight distribution and movement calculations for piping.

F. Shop Drawings and Data: Contractor shall prepare the following drawings:
   1. Fabrication Detail Shop Drawings: These drawings shall show each pipe hanger or support for piping 22 inches nominal size and larger and shall include location of hanger with reference to nearest building columns or beams, arrangements and detail of hanger, detail of concrete anchor or detail of welded or bolted attachment to structural steel, bill of materials for all components with ASTM specification numbers and direction and magnitude of movement and thrusts and weight at hanger point. Provide the load at each concrete anchor.
   2. Hanger and Support Location Shop Drawings: Contractor shall mark all pipe hanger and support locations for piping 22 inches nominal size and larger on Piping Erection Detail drawings. Contractor shall also show all structural grids and support points on these drawings.

1.06 WARRANTY

A. Refer to Section 15000, "Special Requirements for Mechanical and Electrical Work".

PART 2 - PRODUCTS

2.01 PIPE

A. All pipe shall be new, free from scale or rust, of the material and weight specified under the various services. Each length of pipe shall be properly marked at the mill for proper identification with name or symbol of manufacturer.

B. All steel piping, except where otherwise rated, shall be standard or extra strong weight, in conformance with the ASTM A-53 Grade B seamless, for piping 2" and larger, as manufactured by National Tube Division, Republic Steel Corp., or approved equal. Piping shall be ASTM A-53 Grade F continuous butt weld, for piping less than 2".

C. All brass piping shall be standard or extra heavy weight 85% red brass semi-annealed seamless-drawn, in conformance with the ASTM B-43, as manufactured by Anaconda, American Brass Co., Chase Brass and Copper Co., or Revere Copper and Brass, Inc.

D. All copper tubing shall be of weight as required for service specified, with conformance with ASTM B-88 for Types "L" and "K" tubing, as manufactured by Chase, Anaconda, Revere, or approved equal. Tubing and fittings shall be thoroughly cleaned with sand cloth and treated with an approved non-corrosive flux before solder is applied.

E. All galvanized steel piping shall be standard or extra strong weight, as specified, in conformance with the ASTM A-53 Grade B. Pipe shall be hot-dripped zinc-coated with Prime Western smelter and not wiped.

F. Generally, unless otherwise specified, joints in steel piping of sizes 2 inches and under shall be screwed, and all sized 22 inches and over shall be welded or flanged. Brass pipe shall be screwed 2 inches and smaller and flanged 22 inches and over. Copper tubing shall be silver-soldered or 95-5 solder as herein specified.

G. Screwed Piping
   1. All connections to apparatus with screwed piping shall be made with 250 pound brass seat unions.

2. All screwed nipples shall be Schedule 80 nipples.

H. Threaded joints in glycol filled systems shall be made by Radiator Specialty Co. Submit sample and obtain approval.

I. Welding Piping
1. All fittings for welded piping shall be as manufactured by Tube Turn, Grinnell, Bonney Forge or equal as approved by the Architect. The fittings shall be of the same weight and material as the piping to which they are attached.
2. For piping 22" or 4" and larger, full size branch connection shall be made with manufactured welding tees, branch connections for less than full size, shall be made with welding tees or with Weldolet forged branch outlet fittings. Fishmounting, shaped nipples, and stubbing not permitted.

J. Welding outlet fittings shall be Weldolets as manufactured by Bonney Forge, Inc., or approved equal 2 or 3 and smaller branches shall be made with thredolets as made by Bonney Forge or approved equal.

K. Weld ells shall have a center line radius not less than diameter of the pipes.

L. All flanges shall be welding neck flanges ANSI B16.5 ASTM 181 Grade I. all systems, except where otherwise noted - 150 lbs. Class, forged steel.

M. Instrumentation connections :" and smaller on all systems shall be provided by welding threaded 2000# forged steel half couplings to the pipe.

N. All pipe to be welded shall be cut off clean and beveled. All welding shot shall be removed.

O. Composition of welding electrodes shall be in accordance with manufacturer's recommendations.

P. Pipe welding shall comply with the provisions of the latest revision of the applicable code, whether ASME Boiler and Pressure Vessel Code, ANSI Code for Pressure Piping B31, or such state or local requirements as may supersede codes mentioned above.

Q. Before any pipe welding is performed, submit a copy of the welding procedure specifications together with proof of its qualification as outlined and required by the most recent issue of the code having jurisdiction. Submittal shall comply with ANSI/ASME B31.1/B31.9.

R. Before any operator shall perform any pipe welding, also submit the operator's qualification record in conformance with provisions of the code having jurisdiction, showing that the operator was tested and certified under the Procedure Specification as before mentioned. Submittal shall comply with ANSI/ASME B31.1/B31.9.

S. Assume responsibility for the quality of welding done and repair or replace any work not in accordance with these specifications.

T. In addition, all pipe welding procedures and procedures for qualification of pipe welding operators shall comply with the requirements of the American Welding Society.

U. Pipe Schedule: Pipe for the various services shall be as follows:

Service	Material	Schedule
Low Pressure Steam (15 psig & below)	Steel	40 or standard
Low Pressure Condensate	Steel	40 or standard
Pumped Condensate Returns	Steel	40 or standard
Low Pressure Cond. (within 20 feet) Heat Exchanger		80
Vents (steam safety & relief)	Steel	80
Overflow & Drain	Copper	Type K
Cold Water	Copper	Type K
Hot Water	Steel	40

V. The Contractor shall have the option to use Type K copper for hot water piping up to and including 2"

2.02 FITTINGS

A. Fittings shall be specified under "Fitting Schedule" for various services.

B. Welding fittings shall be of the same material and schedule as the pipe to which they are welded. Welding elbows shall be long radius pattern unless clearance conditions necessitate the use of standard radius pattern. Welding fittings shall be as made by Tube-Turn.

C. Fittings shall be of material conforming to the following schedule:

Steel Welding Fittings	ASTM A-106
Malleable Iron Fittings	ASTM A-197
Cast-Iron Fittings	ASTM A-126
Brass Fittings	ASTM B-62
Solder Fittings	ASTM B-88

D. All fittings used at expansion loops or bends shall be extra heavy.

E. Cast-iron, malleable-iron and bronze fittings shall be of Crane manufacturer or approved equal.

F. Flanges shall be raised face, of the same weight as the fittings in each service category. All flanges shall be drilled to "US Standard" hex nuts and washers. Bolting shall conform to ASTM 193 Grade B-7, threads Class 7 fit. Nuts shall be semi-finished hexagonal, ANSI B18.2 ASTM A194 Grade 2H.

G. Unions - Unions 2 inches and smaller shall be screwed. Unions 22 inches and larger shall be flanged. Screwed unions on steel pipe, unless otherwise specified, shall be of malleable

iron with bronze ground seats suitable for 300 pounds W.S.P. Screwed unions on copper or brass pipe shall be brass, ground joint suitable for 300 pounds W.S.P. Flanged unions shall be malleable iron for steel pipe, and brass for copper or brass pipe, gasket type suitable for 150 pounds W.S.P. Unions shall be as manufactured by Crane or approved equal.

H. Unless otherwise specified, all flanged joints shall be fitted with Manville or equal ring gaskets designed for the intended service.

I. Fitting Schedule: Fittings for the various services shall be as follows:

Service	Size	Material	Weight	Type
Low Pressure Steam	2" & below 22" & above	C.I. Steel	125# Sch. 40	Screwed Welding
Low Pressure Condensate	2" & below 22" & above	C.I. Steel	125# Sch. 40	Screwed Welding
Pumped Condensate Returns (discharge)	ALL	C.I.	250#	Screwed
Vents (steam safety & relief)	2" & below 22" to 8"	C.I. Steel	125# Sch. 80	Screwed Welding
Overflow and Drain	ALL	Galv. M.I. Wrought Copper	150# 125#	Screwed Solder
Cold Water	ALL	Bronze Wrought Copper	125# 125#	Brazed Solder

2.03 PIPE HANGERS AND SUPPORTS

A. Provide necessary structural members, hangers and supports of approved design to keep piping in proper alignment and prevent transmission of injurious thrusts and vibrations. In all cases where hangers, brackets, etc., are supported from metal decking and/or concrete construction, care shall be taken not to weaken decking and/or concrete or penetrate waterproofing. All hangers and supports shall be capable of screw adjustment after piping is erected. Hangers supporting piping expanding into loops, bends and offsets shall be secured to the building structure in such a manner that horizontal adjustment perpendicular to the run of piping supported may be made to accommodate displacement due to expansion. All such hangers shall be finally adjusted, both in the vertical and horizontal direction, when the supported piping is hot, or chilled, as required. Hangers in contact with copper or brass pipe shall be copper plated steel.

B. Pipe hangers shall be the clevis and pipe roll types, except where otherwise noted.

PIPE HANGER SCHEDULE				
		Make and Model		
Pipe	Type of Hanger	Grinnell Fig. No.	B-Line Fig. No.	Carpenter & Paterson Fig. No.
2" & smaller (steel)	Clevis Hanger	260	B3100	100
2" & smaller (copper)	Adjustable Wrought Iron	CT-65	B3104CT	100 CT
22" to 4" (steel)	Adjustable Steel Yoke Pipe Roll	181	B3110	140
22" to 4" (copper)	Adjustable Swivel Ring	CT-69	B3170CT	
5" & above	Two Rod Hanger	171	B3114	142

C. Beam clamps - Hangers supported from floor steel shall be approved I beam clamps. I beam clamps for hangers shall be wrought steel. B-Line Fig. B3055 (C&P Fig. No. 268) or equal.

D. Where piping is run near the floor and not hung from the ceiling construction but is supported from the floor, such supports shall be of pipe standards with base flange and adjustable top yoke similar to B-Line Fig. B3091 (C&P Fig. 247) or equal.

E. All vertical piping shall be anchored by means of heavy steel clamps securely bolted or welded to the piping, and with end extension bearing on the building.

F. All vertical piping shall be guided at each floor by use of clamps fastened to building structure. Provide 360E protective saddle at guides. Saddles shall be fastened to pipe or insulation.

G. Vertical runs of pipe not over 15 feet long shall be supported by hangers placed not over one foot from the elbows on the connecting horizontal runs.

H. Vertical runs of pipe over 15 feet long but not over 60 feet long and not over 6 inches in size, or not over 30 feet long and not over 12 inches in size, shall be supported on heavy steel clamps. Clamps shall be bolted tightly around the pipes and shall reset securely on the building structure without blocking. Clamps shall be welded to the pipes or placed below couplings. Clamps shall be B-Line Fig. B3373 or equal.

I. Piping in trenches shall reset or hang from angle iron cross supports provided by the Contractor with two coatings of red primer and final coat for black asphaltum paint.

J. Hanger rods shall be of the following diameters:

Pipe Size	Rod Diameter	Max. Spacing
13 inch & below	d inch	6'-0"
12 and 2 inch	d inch	10'-0" (copper 8'-0")

22 inch		10'-0"
3 inch	2 inch	(copper 8'-0")
4 inch		
5 inch	e inch	12'-0"
6 inch	: inch	14'-0"
8 inch & above	f inch	16'-0"

K. Piping shall not be hung from other piping ducts, conduits or from equipment of other trades and no vertical expansion shields will be permitted. Hanger rods shall not pierce ducts.

L. All water piping connected to rotating equipment within all mechanical spaces shall be isolated from the building structure by means of vibration hangers inserted in the hanger rods. The vibration hangers shall consist of a steel spring in combination with a double deflection neoprene element within a rectangular steel housing. Combined static deflection shall be 1.375" minimum. Hangers shall have capability of supporting the piping at a fixed elevation during installation and shall incorporate an adjusting device to transfer the load to the spring. Deflection shall be indicated by means of scale. Vibration hangers shall be type PCDNHS made by Mason Industries.

M. All steam and condensate piping within all mechanical spaces shall be isolated from the building structure by means of vibration hangers inserted in the hanger rods. The vibration hangers shall consist of a steel spring in combination with a double deflection neoprene element within a rectangular steel housing. Minimum static deflection shall be 1.375". Vibration hangers shall be Vibratol type HESL with options 2 and 4 as made by B-Line Systems, Inc. (Type PCDNHS as made by Mason Industries.)

N. Where additional steel is required for the support of hangers, furnish and install same subject to the approval of the Architect. Piping and ductwork shall not be supported from concrete slab construction at ceiling.

O. All piping running on walls shall be supported by means of hanger suspended from heavy angle iron wall brackets. No wall hooks will be permitted.

P. Lateral bracing of horizontal pipe shall be provided where required to prevent side sway or vibration. The lateral bracing shall be of a type approved by the Architect and shall be installed where directed by the Architect.

2.04 ANCHORS

A. All anchors shall be separate and independent of all hangers, guides, and supports. Anchors shall be of heavy blacksmith construction suitable in every way for the work approved by the Architect. Anchors shall be welded to the pipe and fastened to the structure with bolts.

B. Anchors shall be fabricated and assembled in such a form as to secure the piping in a fixed position. They shall permit the line to take up its expansion and contraction freely in opposite directions away from the anchored points; and shall be so arranged as to be structurally suitable for particular location, and line loading. Submit details for approval.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where the piping is to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Coordinate with other work as necessary to interface installation of piping with other components of systems.

B. Provide and erect in a workmanlike manner, according to the best practices of the trade, all piping shown on the Drawings or required to complete the installation intended by these Specifications.

C. The Drawings indicate schematically the size and location of piping. Piping shall be set up and down and offset to meet field conditions and to provide adequate maintenance room and headroom in the Mechanical Rooms.

D. Study the General Construction Specifications and Plans, of the exact dimension of finished work and of the height of finished ceilings in all rooms where radiation, units, equipment or pipes are to be placed and arrange the work in accordance with the Schedule of Interior Finishes, as indicated on the Architectural Drawings.

E. All exposed piping shall be run perpendicular and/or parallel to floors, interior walls, etc. Piping and valves shall be grouped neatly and shall be run so as to avoid reducing headroom or passage clearance. Provide min. 7'-6" headroom under passageway in mech. equip. room All valves, controls and accessories concealed in furred spaces and requiring access for operation and maintenance shall be arranged to assure the use of a minimum number of access doors.

F. All pipe lines made with screwed fittings must be provided with sufficient number of flanges or unions to make possible any taking down of the pipes without breakage of fittings.

G. All piping shall be erected as to insure a perfect and noiseless circulation throughout the system. No bull head tees will be permitted.

H. All valves and specialties shall be so placed as to permit easy operation and access.

I. Provide proper provision for expansion and contraction in all portions of pipe work, to prevent undue strains on piping or apparatus connected therewith. Provide double swings at riser transfers and other offsets wherever possible, to take up expansion. Arrange riser branches to take up motion of riser.

J. Approved bolted, gasketed, flanges (screwed or welded) shall be installed at all apparatus and appurtenances, and wherever else required to permit easy connection and disconnection. Screwed unions shall be used on piping 2" or less.

K. All piping connections to coils and equipment shall be made with offsets provided with screwed or welded bolted flanges so arranged that the equipment can be serviced or removed without dismantling the piping.

L. If, after plant is in operation, any coils or other apparatus are stratified or air bound (by vacuum or pressure), they shall be repiped with new approved and necessary fittings, air vents, or vacuum breakers at no extra cost. If connections are concealed in furring, floors, or ceilings, bear all expenses of tearing up and refinishing construction and finish, leaving same in as good condition as before it was disturbed.

M. Fittings shall be of the eccentric reducing type, where changes of size occur in horizontal piping to provide for proper drainage or venting. Steel pipe bends shall be made of the very best grade open hearth, low carbon steel, leaving a smooth uniform exterior and interior surface. Pipe bends shall be made with seamless steel pipe, having a minimum radius of not less than five (5) pipe diameters.

N. Tubing shall be erected neatly in a workmanlike manner. Bends in soft copper tubing benders to prevent deformation of the tubing in the bends. Approved seat-to-pipe threaded adapters shall be provided for junctions with valves and other equipment having threaded connections.

O. Vertical sections of main risers shall be constructed of pipe lengths welded together. No couplings shall be used.

P. The ends of all pipe and nipples shall be thoroughly reamed to the full inside diameter of the pipe and all burrs formed in the cutting of the pipes shall be removed.

Q. Piping shall be installed in accordance with the latest edition of the ASME Code for Pressure Piping.

R. All piping shall be concealed above furred ceilings in rooms where such ceilings are provided (except where specifically indicated otherwise on the drawings, or in walls or partitions, except as otherwise indicated).

S. Dissimilar piping shall be connected with dielectric connector as made by Ebco Company or approved equal.

T. Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping shall be supported to allow for removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional supports after these items are removed.

U. Pipe nipples - Any piece of pipe 3" in length and less shall be considered a nipple. All nipples with unthreaded portion 12" and less shall be extra heavy. Only shoulder nipples shall be used. No close nipples will be permitted.

V. Screw threads shall be cut clean and true; screw joints made tight without caulking. No caulking will be permitted. A non-hardening lubricant shall be used. No bushings shall be used. Reductions, otherwise causing objectionable water or air pockets, to be made with eccentric reducers or eccentric fittings.

W. Pitch steam and condensate lines downward one inch per 40 feet in direction of flow to ensure adequate flow and prevent noise and water hammer. Steam and return run outs to risers and to elements shall pitch 2 inch per foot. At low points of steam lines provide

traps adequately sized to collect condensate. Mains shall be dripped at least every 100 feet of run. All supply mains shall be dripped and trapped on any vertical lift, except where otherwise noted. Provide capped dirt pockets at all traps, riser heels, and wherever dirt and scale may accumulate to meet job conditions, mains shall set up (with drip connections to return line) to maintain headroom, clear other pipes, etc. Steam mains are to be installed as high as possible. System is to be arranged to secure venting of air to the return line at all low points in steam mains, without permitting ingress of air. In any case, where return or drip piping, to meet job conditions, may have to set down under stoops, doors, etc., and again rise after passing these, the sets shall be made up with 45 deg. fittings and with Y-laterals at each end, with brass plugs to permit easy cleaning of trapped portions of pipe. At any points where return mains have to rise again, after being depressed, provide also approved overhead "air lines" (not smaller than :" in size) with adjusting valves, and connect with two high sides. Any turns in water sealed lines shall be made with crosses, with brass plugs in unused outlets to facilitate cleaning. All apparatus subject to high temperature differentials and high steam demand loads such as heating coils, domestic hot water heaters and steam-water converters, shall have a vacuum breaker.

X. Pitch water piping upward one inch per 100 feet in direction of flow to ensure adequate flow without air binding, and to prevent noise and water hammer. Pitch drain piping c inch per foot in the direction of flow. Branch connections to mains are to be made in such a manner as to prevent air trapping and permit free passage of air. To meet job conditions, mains shall set up to maintain headroom, and clear other trades. Provide oversized float operated automatic air vent (with valve). Avoid 90 deg. lift set-ups in supply lines by using 45 degree ells. Where 90 deg. lifts exceed 12" install automatic air vent in supply lines. All lifts in return lines shall be installed with automatic air vents. Pipe outlet of all automatic air vents to an open sight drain if the vent is concealed, or to within two feet of the floor within machine rooms. All water piping shall pitch back to low points for drainage. Low points shall be provided with : inch hose cocks.

Y. Provide drain valves at the heel of all interior main water risers. Provide drain valves at the heel of all perimeter water risers.

Z. Miscellaneous drains, vents, reliefs, and overflows from tanks, equipment, piping, relief valves, pumps, etc., shall be run to the nearest open sight drain or roof drain. Provide drain valves whenever required for complete drainage of piping, including the system side of all pumps.

AA. Provide domestic water connections from valved outlets to any equipment requiring same.

BB. All drain piping from condensate drain pans shall be properly trapped in accordance with the static pressures involved. Condensate drain piping sizes shall be not less than 12".

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of piping (partial or complete) test piping to demonstrate compliance with requirements. Where possible, field correct malfunctioning piping, then retest to demonstrate compliance. Replace piping which cannot be satisfactorily corrected. Refer to Section - Testing and Balancing.

END OF SECTION 15820

SECTION 15830

VALVES FOR HVAC

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, all Valves as shown on the drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. "Manufacturers" - Firms regularly engaged in manufacture of valves, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Provide valves produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".

C. Provide valves whose performance under specified conditions, is certified by the manufacturer.

1.04 SUBMITTALS

A. Refer to Section 15000 - Special Requirements for Mechanical and Electrical Work and submit shop drawings.

B. Submit pressure temperature ratings for all valves.

1.05 GUARANTEE

A. Refer to Section 15000 - Special Requirements for Mechanical and Electrical Work.

PART 2 - PRODUCTS

2.01 VALVES

A. Valves- General: All valves shall be of a design which the manufacturer lists for the service and shall be of materials allowed by the latest edition of the ASME Code for pressure piping for the pressure and temperature contemplated, unless a higher grade or quality is herein specified. All valves shall be of the same manufacturer, except for special applications.

B. The system shall be supplied with valves in all branch mains and risers, at all pumps, tanks, reducing and control valves, heating and cooling surfaces and at all apparatus; so located, arranged and operated as to give complete shut-off. Except where flanged valves are used, each connection to equipment shall be made with screwed or flanged unions on the equipment or discharge side of the valve.

C. All valves shall be installed with the best workmanship and are to have neat appearance and be arranged so that they are easily accessible.

D. Each valve shall have the maker's name or brand, the figure or list number and the guaranteed working pressure cast on the body or stamped on the bonnet, or shall be provided with other means of easy identification.

E. Check valves installed in the horizontal position shall be swing checks; valves installed in the vertical position shall be silent checks for 22" and above, and lift check for 2" and smaller, except that all check valves in pump discharges shall be silent checks.

F. Provide blow-off valves at all strainers, and where shown on the Drawings.

G. Provide valve operating chain on all gate, globe, butterfly and plug valves in Mechanical Equipment Rooms - 4" and larger, which are more than 7'-0" above the operating floor. Unit shall be complete with adjustable sprocket, chain and guide (Crane "Babbit" type). Provide hook to keep chain out of the way.

H. Generally, all valves are to be of the gate type, except that globe valves shall be used for balancing service, throttling services and on traps, and pressure reducing and control valve bypasses. Globe valves used on bypasses shall have monel metal mountings. Pumps shall have globe type balancing flow measuring & shut off valves on discharge piping.

I. All valves 2 inches in diameter and smaller shall be all bronze with bronze bodies. Valves 22 inches in diameter and larger shall have iron bodies with bronze mountings (except where otherwise noted).

J. All flanged-end valves shall have renewable metal seat rings and discs. On gate valves these parts shall be of bronze, on all globe valves they shall be of bronze and suitable for throttling service.

K. All screwed-end globe valves shall be of the union bonnet type with renewable teflon discs.

L. All valves shall have their bonnets back-seated to provide for packing under pressure. All gate valves shall be of the solid tapered wedge type.

M. All steam valves 5 inches and larger shall be furnished with an integral bypass and a bypass valve suitable for the operating pressure.

N. Drain valves shall be provided on tanks, receivers, risers and where they may be required or necessary, for draining the lines and equipment. Drain valves or plug cocks shall be provided at the low points for proper drainage. Cocks and valves shall be provided with threaded ends for those connections.

O. All valves up to 2 inches in diameter shall have screw ends, 22 inches in diameter and over shall have flanged ends. Valves 22" and larger which are non-rising stem, shall have position indicators.

P. All bronze and iron valves shall be furnished with Teflon impregnated packing.

Q. All handwheels shall be of malleable iron.

R. No Asbestos shall be used in construction of valves including the gaskets.

S. All valves shall be of type and number as specified below: For all services, except as otherwise noted.

TYPE	SIZE	CRANE NO.	JENKINS NO.	WALWORTH NO.	REMARKS
Gate Valve	2" & Smaller	428UB	47U	2	150 lb. WSP, Bronze,
	22" & Larger	4652	651C	726F	Rising Stem 125 lb. WSP, Bronze Trimmed, Iron Body, OS&Y
Globe Valve	2" & Smaller	142P	546P	237P	300 lb. WSP, Bronze.
	22" & Larger	351	613C	906F	125 lb. WSP, Bronze Trimmed, Iron Body OS&Y
Angle Valve	2" & Smaller	162	558P	238P	300 lb. WSP, Bronze
	22" & Larger	353	907F		125 lb. WSP, Bronze Trimmed, Iron Body, OS&Y
Swing Check	2" & Smaller	137	409Z	406	150 lb. WSP, Bronze
	22" & Larger	373	624	M928F	125 lb. WSP, Bronze Trimmed, Iron Body.
Silent Check	All Sizes	----	-----	-----	Williams-Hager, Fig. 636, 125 WSP, Semi-steel.
Drain Valves	2" & Smaller	451	372N (2/4" size only)	24	200 lb. OWG, non-rising stem, Hose end, Bronze with Bronze Cap & Chain
Blow-Off Valves	2" & Smaller	----	124	----	300 lb. WSP, Bronze Y-Type

TYPE	SIZE	VICTAULIC NO.	REMARKS

TYPE	SIZE	VICTAULIC NO.	REMARKS
Butterfly Valve	22" & Larger	Vic_-300 MasterSeal_	300 psi CWP, Ductile Iron Body, Nickel Plated Ductile Iron Disc
Check Valves	22" & Larger	716	300 psi CWP, Ductile Iron Body, Aluminum Bronze or Elastomer Encapsulated Ductile Iron Disc
Balancing Valves	All Sizes	Tour and Anderson	300 psi CWP Ametal_ or Ductile Iron Body Globe Style

T. Valves for radiation & gas service shall be as follows:

U. Hot Water Radiation Shut-off all sizes, 200 psi water, Sarco No. 740A with lock shield.

V. Radiation Balancing - All sizes, 200 psi water, bronze, male union outlet, combination balancing, shut off and flow measuring, Sarco metered balance master valve, or approved equal. Provide model flow test kit.

2.02 LUBRICATED PLUG VALVES

A. Full port opening tapered plug suitable for lubrication under service pressure with plug in any position.

B. Lubricating Guns:
1. One for every 10 valves.
2. Extra heavy, lever type, hydraulic hand gun.
3. 15,000 psi gauge and 12" long connection hose.
4. Similar to Walworth or Crane.

C. Lubricant:
1. Manufacturer's recommendations.
2. One year supply, each valve.

D. Operators:
1. 4" to 6", wrench, except as noted.
2. Wrench set for each size valve.
3. Wrench for every 10 valves, each size
4. 8" and larger: gear operated.
5. Permanently installed handwheel.

2.03 BALANCING VALVES

A. All balancing valves shall be combination balancing, flow measuring and shut off valves. Valves shall be globe style design and shall have a position indicator and memory stop or locking device so that the valve can be closed without disturbing the setting and returned to the balanced position without further adjustment.

B. Valves shall be as manufactured by Andersonn, Inc.

C. Nominal working pressure for the valves shall be 300 psig or greater at 230EF.

D. Provide portable flow measuring instruments which shall be turned over to the Owner at the completion of work.

E. Butterfly valves can be used for balancing and shutoff valves for pipes larger than 6" provided a separate flow measuring device is located in the pipe upstream or downstream of the valve and the valve is provided with position indication and memory stop. Butterfly valves shall not be used at pump discharge.

2.04 BALL VALVES

A. Ball Valves up to 2" may be used for all water services as an alternate to gate valves.

B. Ball valves shall be bronze body, bronze ball and stem, Teflon seats and seals threaded ends, 400 psig cold W.O.G. Worchester No. 411T-SE or equal. "APOLLO" 70 - 100 Series.

2.05 BUTTERFLY VALVES

A. Butterfly valves may be used for as an alternative to gate valves and balancing valves for sizes 3" and above for chilled water and condensate only. If used for balancing valves, they shall provide a full range of control. Submit C_V vs. valve position curves for review & approval.

B. Valves shall be similar to Keystone. Butterfly valves shall not be directly connected to equipment without a spool piece. All valves shall be suitable for dead end service.

C. Design working pressure: 175 psi.

D. Valves in insulated piping: necks to extend 2 inches above outside diameter of flanges to accommodate full thickness of insulation.

E. Operators:
   1. Valves to 8": handles with minimum of 10 locking positions and adjustable memory stop.
   2. 8" and larger: gear operators with adjustable balance return stops and position indicators.

F. Body: Cast iron or malleable iron.

G. Flanges: Wafer type bodies are not acceptable.

H. Valves in piping that may be removed up to valve: bodies flanged.

I. Stems: 304, 316 or 17-4PH stainless steel with EPDM ring slabs or V-packing: Phosphate coated alloy steel accepted if stem does not come in contact with water.

J. Discs: aluminum bronze

K. Seats: replaceable EPDM

L. Design working pressure: 175 psi.

M. Factory test: bubble tight at 190 psi.

N. Dead end test: 100 psi.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where valves are to be installed and determine space conditions and notify architect in writing of conditions determined to proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install valves where shown or specified, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that valves comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interfere installation of valves other components of systems.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of valves, test valves to demonstrate compliance with requirements. When possible, field correct malfunctioning valves, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

END OF SECTION 15830

SECTION 15840

SHEET METAL DUCTWORK

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, all Sheet Metal Ductwork as shown on the drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Fabrication and installation shall be by a single firm specializing and experience in metal ductwork for not less than 10 years.

B. Comply with SMACNA (Sheet Metal and Air Conditioning Contractors National Association) recommendations for fabrication, construction and details and installation procedures, except as otherwise indicated.

C. Comply with ASHRAE (American Society of Heating Refrigeration and Air Conditioning Engineers) recommendations, except as otherwise indicated.

D. Compliance to SMACNA and ASHRAE is a minimum requirement. In case of disagreement between sheet metal work described in this Section and SMACNA or ASHRAE, the specification shall govern.

1.04 SUBMITTALS

A. Refer to Section 15000 - Special Requirements for Mechanical and Electrical work and submit shop drawings and coordinate drawings.

1.05 COORDINATION

A. Refer to Section 15000 - Special Requirements for Mechanical and Electrical work.

1.06 GUARANTEE

A. Refer to Section 15000 - Special Requirements for Mechanical and Electrical work.

1.07 PRODUCT HANDLING

A. Protect shop fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Protect ends of ductwork and prevent dirt and moisture from entering ducts and fittings.

B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR DUCTWORK

A. Furnish and install the size, connections and run of ducts as indicated on the drawings.

B. While the Drawings shall be adhered to as closely as possible, the Architect's right is reserved to vary the run and size of ducts during the progress of the work if required to meet structural conditions.

C. Install all ductwork in strict adherence to the ceiling height schedule indicated on the Architect's Drawings. Consult with the Electric and Plumbing Subcontractors, and in conjunction with the above Subcontractors, establish the necessary space requirements for each trade.

D. The sheet metal ductwork shall, whether indicated or not, rise and/or drop and/or change in shape to clear any and all conduits, lighting fixtures, plumbing and heating mains (new and existing) to maintain the desired ceiling heights, and to provide adequate maintenance room and headroom in mechanical equipment rooms.

E. The ductwork shall be continuous, with airtight joints and seams presenting a smooth surface on the inside and neatly finished on the outside. Ducts shall be constructed with curves and bends so as to effect an easy flow of air. Unless otherwise shown on the Drawings, the inside radius of all curves and bends shall be not less than width of ducts in plane of bend.

F. All rectangular ductwork, unless otherwise noted, shall be built from galvanized sheet steel and thoroughly braced and stiffened.

2.02 DUCT FABRICATION

A. Ducts shall be neatly finished on the outside with all sharp edges removed.

B. Inside surfaces shall be smooth with no projections into the air stream except where otherwise indicated.

C. Longitudinal joints shall be Pittsburgh lock at corners or Acme lock on flat surfaces double seams hammered tight and shall be located above the horizontal axis of the duct. A snap lock seam shall not be permitted as a substitute for the Pittsburgh lock at corners of ducts.

D. Transverse joints shall be made airtight with all laps in the directions of air flow.

E. All fasteners and attachments shall be made of the same material as the ducts.

F. Furnish test wells 12" on the center horizontally and vertically in the suction and discharge duct of each fan. Test wells shall consist of a 1" x :", 125 lb., bronze, screwed hex bushing, secured to the duct with a bronze hex locknut on the inside of the duct. A :" x 2" long standard weight bronze, screwed nipple and cap shall be fitted to the housing on the outside of the duct. Test wells shall be No. 699 as made by Ventlok or approved equal.

G. All radius elbows shall have a minimum centerline radius of 12 times the width of the duct.

H. All square elbows shall have factory-designed and built single thick turning vanes. Shop fabrication vanes will not be approved. Where turning vanes are in conflict with the access doors to fire dampers. They shall be made movable, so that fire dampers shall be accessible.

I. Dissimilar metals shall be connected with flanged joints made up with fiber or neoprene gaskets to prevent contact between dissimilar metals. Flanges shall be fastened with bolts protected by ferrules and washers made of the same materials as the gaskets. Where an aluminum duct is to be connected to a galvanized steel duct, the end of the galvanized steel duct shall be coated with heavy black asphaltum paint before connecting it to the aluminum duct.

J. Changes in shape and dimension shall conform to the following: Except where otherwise noted, for increases in cross-sectional area, the shape of the transformation shall not exceed 1" in 7". Except where otherwise noted, for reductions in area, the slope shall not be less than 1" in 4" but 1" in 7" preferred.

K. Wherever it may be necessary to make provisions for vertical hangers of the ceiling construction passing through ducts, provide streamlined shaped sleeves around such ceiling construction hangers as to fully protect the duct from being punched with holes for the passage of such hangers. Any such streamlined sleeves shall be made air tight at top and bottom of ducts. In no case shall there be more than two rods in any 9 sq. ft. area. No rods shall pierce ducts smaller than 12" in horizontal area.

L. The construction for low pressure rectangular sheet metal ducts shall be made in accordance with recommendations of ASHRAE Guide, Latest Edition, or as per SMACNA Manual for a 2” pressure class (positive or negative as appropriate) and a Class A seal.
   1. Flat areas of duct over 18 in. wide shall be stiffened by cross breaking of beading.
   2. All joints to have corner closures.
   3. All joints (longitudinal and transverse) shall be sealed with 3M EC-800 mastic to provide sealing equivalent to SMACNA Seal Class A.

2.03 ACCESS DOORS IN SHEET METAL WORK

A. Wherever necessary in ductwork, casings or sheet metal partitions, provide suitable access doors and frames to permit inspections, operation and maintenance of all valves, coils, humidifiers, controls, smoke dampers, smoke detectors, fire dampers, filters, bearings, traps, or other apparatus concealed behind the sheet metal work. All such doors shall be of double construction of not less than No. 20 gauge sheet metal and shall have sponge rubber gaskets around their entire perimeter. Doors in insulated ducts of insulated casings shall have rigid fiberglass insulation between the metal panels.

B. All access doors in sheet metal ducts shall be hung on heavy flat hinges and shall be secured in the closed position by means of cast zinc clinching type latches. Where space conditions preclude hinges, use four heavy window type latches. Doors into ducts shall in

general not be smaller than 18" x 18" except for access door to fire dampers which will depend on size of fire damper.

C. In no case shall access to any items of equipment requiring inspection, adjustment, or servicing require the removal of nuts, bolts, screws, wing nuts, wedges, or any other screwed or loose device.

D. Each sheet metal chamber shall have access doors for access to all parts of the system. Doors shall be fitted with cast zinc door latches, two per door. Latches shall be operable from both sides of casing. Hinges shall be extra heavy, zinc plated hinges, minimum of two per door. The doors shall be felted or provided with rubber gaskets so as to make them airtight. The doors shall be made with inner and outer shells 2 inches apart so that they may be properly insulated and properly operated. Doors shall be a minimum size of 20" x 48".

E. Hinges shall be Ventlok No. 150 or 260 with or without screw holes or approved equal. Latch for walk-in access doors shall be No. 260 as made by Ventlok Co. or approved equal. Latch for access door in ductwork shall be Ventlok No. 100 or approved equal.

F. Where reheat coils are installed in ductwork, provide two (2) access doors; one on the upstream side of the coil and one on the downstream side of the coil, both within 2'-0" of the coil.

G. Access doors at humidifier locations shall be provided on both sides of duct.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where ductwork is to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF DUCTWORK

A. Install ductwork in accordance with recognized industry practices, to ensure that ductwork complies with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation or ductwork with other components of systems.

C. Duct sizes shown on the drawings at connection to fans or other equipment may vary in actual installation. Contractor shall provide transition pieces as required.

D. Ducts, casings and hangers shall be installed straight and level and shall be free of vibration and noise when fans are operating.

E. Ducts at ceilings shall be suspended from inserts in concrete slabs except where otherwise indicated. Inserts shall be Grinnell Fig. 279, 282, or 152 as required. Ducts at floor shall be supported by steel angles suitably anchored to floor construction. Each duct shall be

independently supported and shall not be hung from or supported by another duct, pipe, conduit or equipment of any trade.

F. Supports shall be placed at each joint and change in direction up to a maximum spacing of 8 feet on centers. Prevent buckling of ductwork.

G. All fastenings to building structure shall be adequate to insure permanent stability of sheet metal work and shall be capable of resisting all applied forces.

H. Vertical ducts in shafts or passing through floors shall be supported by steel angles or channels, welded, riveted, screwed or bolted to ducts and fastened to building structural members at each floor level. Provide safing to close all floor openings around ductwork - pack annular space with rockwool and 18 gauge sheet metal safing Floor openings in plenums shall have 2 inch diameter steel bars.

I. Rigid connections between ductwork and non-rotating equipment shall be made with flanged joints, sealed with fireproof material (Fiber or Neoprene gaskets).

J. It is the intent to obtain low pressure ductwork construction with minimum leakage. The construction noted in Specifications can produce low or high leakage rates, depending upon the workmanship, particularly with regard to the connection at the top of the ducts. Guarantee that total diffuser volume, measured by means of velometer, shall be at least 95% of actual fan supply (measured by means of a duct traverse taken with a Pitot tube and water manometer). Seal the ductwork at all joints (longitudinal & transverse and duct wall penetrations) with suitable sealers 3M EC-800 and tape equivalent to SMACNA seal class A. Use of "HARDCAST" or any other material is subject to Architect's approval.

3.03 DUCT HANGERS

A. Low pressure ducts up to 24" on a side or up to 20" diameter shall be suspended with 16 gauge, galvanized strap hangers, 1" wide.

B. Low pressure ducts 25" to 40" on a side or 21" to 42" diameter shall be suspended with galvanized strap hangers 1" wide by c" thick.

C. Strap hangers shall be bent 90E, extended down sides of ducts and turned under bottom of ducts a minimum of 2". Strap hangers shall be fastened at ceiling with nuts, bolts and lock washers and to sides and bottom of ducts with sheet metal screws.

D. For any ducts which require seismic bracing, provide trapeze and rod type hangers regardless of duct size.

E. Rod type hangers shall be d" diameter black steel rods threaded at both ends and bottom bracing angles on ducts, with nuts and lock washers.

F. Angle type hangers shall be extensions of side bracing angles on ducts, bent 90E at ceiling and fastened with nuts, bolts and lock washers.

G. Hangers for vertical ducts shall be as per SMACNA Duct Manual.

3.04 CLEANING AND PROTECTION

A. Clean ductwork internally, unit by unit as it is installed of dust and debris. Clean external surfaces of foreign substances, which might cause corrosion, deterioration of metal or interfere with painting.

B. At end of ducts which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering.

C. Cleaning of new and existing supply ductwork in existing buildings. After completion of ductwork installation clean ductwork as follows:
   1. Cover all supply registers and diffusers with oil cheese cloth.
   2. Use supply fan or install temporary fan to provide air to the system for four (4) hours.
   3. Remove oil cheese cloth.

END OF SECTION 15840

SECTION 15850

INSULATION FOR HVAC WORK

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. The work includes furnishing and installing all labor, materials, equipment, accessories and services necessary to provide Piping, Ductwork and Equipment Insulation installation, which is complete in every respect and of the composition and quality as shown on the Drawings and hereinafter specified.

1.03 PIPE INSULATION

A. The following pipes shall not be insulated. Insulate all other piping:
   1. Steam traps.
   2. Unions.
   3. Automatic air vent drain pipes.
   4. Drain piping from safety relief valve drip pan elbows and steam exhaust heads.
   5. Vent piping from duplex condensate pumps.
   6. Piping under radiation cover.
   7. Steam condensate piping in mechanical equipment room, above 7'-0" finished floor.

1.04 QUALITY ASSURANCE

A. "Installer": A firm with at least ten 10 years successful installation experience on projects with piping and ductwork insulation similar to that required for this project.

B. All insulation shall have composite (including insulation jacket or facing and adhesive) fire and smoke hazard ratings as tested by procedure ASTM E-84, NFPA 255 and UL 723 not exceeding:
   1. Flame Spread 25
   2. Smoke Developed 50
   3. Fuel Contributed 50

C. Accessories such as adhesives, mastics, cements, tapes and cloths for fittings shall have component ratings as listed above. All products shall bear UL labels indicating the above are not exceeded.

D. Provide certifications or other data as necessary to show compliance with these Specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

E. Provide products produced by the manufacturers which are listed in Section "Approved Manufacturers List"

F. Insulation Materials: Insulating materials manufacturing facilities must be certified and registered with an approved registrar for conformance with ISO9000 quality standard.

1.05 SUBMITTALS

A. Refer to Section 15000 - "Special Requirements for Mechanical and Electrical Work", and submit shop drawings and samples.

1.06 GUARANTEE

A. Refer to Section 15000 - "Special Requirements for Mechanical and Electrical Work".

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation; remove from project site.

B. Deliver insulation, coverings, cements, adhesives and coatings to the site in factory-fabricated containers with the manufacturer's stamp, or label, affixed showing fire hazard ratings of the products.

C. Store insulation in original wrappings and protect from weather and construction traffic.

PART 2 - PRODUCTS

2.01 HOT PIPE INSULATION

A. The following piping shall be covered with fiberglass insulation:

Service	Thickness
Low Pressure Steam (15 psig and below)	
Up to 1-1/2"	1-1/2"
2" and above	3"
Steam Condensate and Condensate Pump Discharge	
Up to 1-1/4"	1-1/2"
1-1/2" and above	2"
Hot Water Supply and Return	
Up to 1½"	1½"
2" and above	3"
Exposed L.P. Steam Safety and Relief Vent	1"
Boiler Feed Water Suction and Discharge	2"

B. Insulation shall be glass fiber complying with ASTM C547, Type I with a maximum K factor of 0.23 at 75 degrees F. mean temperature. Insulation shall be suitable for 650 degree F. (2" minimum thickness above 450 degrees F.).

C. Insulation shall be sectional pipe insulation as made by Owens- Corning Fiberglass Corp., or Johns Manville Micro-Lok fiberglass pipe insulation, with all purpose white kraft reinforced jacket with self-seal lap to comply with ASTM C1136 Type I.

D. Longitudinal jacket laps and butt strips shall be smoothly secured per manufacturers recommendations.

E. All fittings, valves and flanges for pipe sizes smaller than 4" shall be insulated with molded fiberglass fittings of same thickness as the adjoining pipe insulation, secured with No. 20 gauge galvanized annealed steel wire and coated with 3" thick finishing cement, BNZ No. 375, or equal. Zeston 2000 25/50 PVC fittings was as made by Johns Manville are approved.

F. All fittings, valves and flanges for pipe sizes 4" and larger shall be insulated with fabricated mitered segments of pipe insulation of same thickness as the adjoining pipe insulation, secured with No. 20 gauge galvanized annealed steel wire and coated with 3" thick finishing cement. Smooth coat as made by Insulation Industries. Zeston 2000 25/50 PVC fittings by Johns Manville are approved.

G. All fittings, valves and flanges exposed to view not covered by Zeston 2000 PVC fittings shall be additionally finished with glass insulating fitting cloth or equal smoothly adhered and coated with Benjamin Foster 30-36. Lap to be at least 1" on pipe insulation below 4" and 2" on sizes 4" and above.

H. Insulation shall be protected by saddles from hangers, guides and rollers.

I. Strainers on hot pipes shall not be insulated.

J. Direct contact between pipe and hanger shall be avoided. Hanger shall pass outside of a metal saddle which shall cover a section of high density insulation (such as calcium silicate) of sufficient length to support pipe without crushing insulation. Hangers shall not pierce insulation and all vapor barriers shall be unbroken and continuous.

2.02 PVC INSULATED FITTING COVERS

A. The Contractor shall have option to use Zeston 2000 25/50 rated PVC covers as made by Johns Manville or approved equal.

B. Hot Systems: Fittings shall be insulated by applying the proper factory precut Hi-Lo Temp insulation insert to the pipe fitting. The ends of the Ho-Lo Temp insulation insert shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe covering tufted and tucked in, fully insulating the pipe fitting. PVC fitting cover is then applied and shall be secured by tack fastening, banding or taping the ends to the adjacent pipe covering.

C. 2 or more layers of the Hi-Lo Temp insulation inserts shall be applied with the first layer being secured with a few wrappings of fiberglass yarn.

D. Qualifications for Using Insulation: When the pipe insulation thickness is greater than 12" or the pipe temperature is greater than 250EF or less than 45EF, additional insulation

inserts should be used. Use one Hi-Lo Temp insert for each additional 1" of pipe insulation.

E. Fitting cover: The temperature of the PVC fitting cover must be kept below 150EF by the use of proper thickness of insulation and by keeping the PVC cover away from contact with, or exposure to, sources of direct or radiant heat.

2.03 FIRE STOPPING

A. Packing of openings, where ducts and pipes penetrate fire barriers, shall be done with Rockwool insulation as made by United States Gypsum, Co.

B. Insulation shall comply with Fed. Spec. HH-1-558, Form A, Class 4, K=0.24, melting point 2000 degrees F.

2.04 EQUIPMENT INSULATION

A. Heating in-line air separators and heat exchangers shall be insulated with 2" thick calcium silicate, Thermo 12 Gold throughout laid with staggered joints and secured in place with No. 16 gauge galvanized annealed steel wire for small areas and No. 12 gauge galvanized annealed steel wire or 2" x 0.015" galvanized steel bands on 12" maximum centers for large areas. Where required, welded studs, clips or angles shall be provided as anchors for wires and bands.

B. Over the insulation, 2" hexagonal mesh wire shall be tightly stretched in place and secured by wiring to anchors with edges tied together.

C. Finish shall be insulating and finishing cement approved equal applied 2" thick in one coat, trowelled to a smooth finish. Provide pre-sized glass cloth, smoothly adhered with B-F 85-20 adhesive over cement.

D. Heat exchanger insulation shall be finished with .016" aluminum jacketing banded in place with 2" aluminum bands 12" on center.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where this insulation is to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install insulation in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that insulation complies with requirements and serves intended purposes.

B. Coordinate with other work as necessary to interface installation of insulation with other components of systems.

C. All insulating materials shall be applied only by experienced workmen, in accordance with the best covering practice. All piping or equipment shall be blown out, cleaned, tested and painted prior to the application of any covering. Adhesives, sealers and mastics shall not be applied, when the ambient temperature is below 40EF., or surfaces are wet.

D. At all openings in insulation, insulate edges neatly and protect with sheet metal frames.

E. All items described in general indicate the type of covering required, however, all piping or equipment that transmits heat or will form condensation shall be insulated.

F. Finish for Concealed Pipe Insulation:
   1. Hot Pipe - Factory ASJ (All service jacket) secured in place with Bostich staples 4" o.c. or ASJ with self sealing lap as made by Johns Manville, Owens-Corning or approved equal.

G. Finish for Exposed Pipe Insulation:
   1. All insulated condenser water piping exposed to weather and all other insulated pipe exposed to weather shall have 0.016" thick aluminum jacket banded with ½" stainless steel bands spaced 12" o.c.

H. All piping insulation shall be continuous through non-fire rated ceiling openings and sleeves passing through non-fire rated walls or floors. Sleeves shall be packed with mineral wool or thermofiber. Discontinue insulation as it passes through fire-rated wall or floor and use mineral wool or thermofiber packing instead. Specific mastics, adhesives and coating shall be applied in strict accordance with Manufacturer's instruction, including recommended coverages.

I. All valved and capped outlets left for future work shall be insulated as herein specified for the specific systems with a removable section of insulation over caps.

J. Where insulation on existing piping, equipment, etc., has been cut, removed or damaged, this Contractor shall reinsulate as herein specified.

K. All insulation of access doors shall be set in sheet metal double-pan construction.

3.03 PROTECTION

A. The installer of the ductwork insulation shall advise the Contractor of required protection for the insulation work during the remainder of the construction period, to avoid damage and deterioration.

END OF SECTION 15850

SECTION 15900

TESTING AND BALANCING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 DESCRIPTION OF WORK

A. All piping and equipment shall be tested. Labor including standby electrician, materials, instruments and power required for testing shall be furnished unless otherwise indicated under the particular Section of the Specification.

B. Tests shall be performed in the presence of and to the satisfaction of the Architect and such other parties as may have legal jurisdiction.

C. In no case shall piping, equipment, or accessories be subjected to pressure exceeding their ratings.

D. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Architects.

E. Any damage resulting from tests to any and all trades shall be repaired and damaged materials replaced, all to the satisfaction of the Architect.

F. The duration of tests shall be as determined by all authorities having jurisdiction, but in no case less than the time prescribed below.

G. Equipment and systems which normally operate during certain seasons of the year shall be tested during the appropriate season. Tests shall be performed on individual equipment, systems, and their controls. Whenever the equipment or system under test is interrelated and depends upon the operation of other equipment, systems and controls for proper operation, functioning and performance, the latter shall be operated simultaneously with the equipment or system being tested.

H. All fans and duct systems shall be completely balanced by the adjustment of sheaves, dampers, registers and other volume and diverting control devices, to obtain the air quantities indicated on the design drawings. Replace sheaves if required to meet design conditions.

I. All pumps and piping systems shall be completely balanced by the adjustment of plug cocks, globe valves or other control devices, to obtain flow quantities indicated on the design drawings.

J. Tests shall be performed in presence and to satisfaction of Architect, and such other parties as may have legal jurisdiction. Submit completed reports for approval. If air and water balancing cannot be verified in two, four hour tests (total of eight hours) the Contractor shall pay the Architect or his representative for any additional time spent to balance the system.

1.03 QUALITY ASSURANCE

A. Prior to installation of the mechanical systems, engage the services of an independent air and water balancing firm that shall be subject to the approval of the Architect. The firm shall have no affiliation with a mechanical contracting or sheet metal company. Balancing and testing company shall be a member of the Associated Air Balance Council. The balancing firm shall have at least one member of its full time staff who is a licensed professional engineer who shall supervise the balancing work. Prior to balancing, a list of instruments to be used shall be submitted to the Architect. All instruments shall be calibrated within six months before tests.

B. When all specified testing and balancing procedures have been completed, a written report shall be submitted to the Architect for review. The report shall be tabulated in standard AABC format. As part of the Architect's review process, the accuracy of the balancing report shall be field spot checked on a random basis, with the assistance of the balancing firm's project supervisor. The HVAC Contractor shall reimburse the Architect for all time spent in excess of eight working hours, to demonstrate the accuracy of the balancing report.

1.04 SUBMITTALS

A. Refer to Section 15000 "Special Requirements for Mechanical and Electrical Work". Submit all test and balancing reports as described hereinafter.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 FIELD TEST OF PIPING

A. During construction properly cap or plug all lines to prevent the entrance of sand, dirt, etc. The system of piping shall be blown through wherever necessary after completion (for the purpose of removing grit, dirt, sand, etc., from all equipment and piping), for as long a time as is required to thoroughly clean the apparatus.

B. Use anti-freeze solution for piping to be tested in winter.

C. All piping shall be tested as hereinafter specified. Tests shall be made after erection and before covering is applied or piping painted or concealed, and as sections of mains and groups of risers are completed. The extent of the work completed before pressure tests are made shall be determined by the Architect.

D. All piping, unless otherwise specified, shall be tested to a hydrostatic pressure at least 1-1/2 times the maximum designed working pressure (but not less than 50 lbs. per square inch) for a sufficiently long time to detect all leaks and defects; and after testing shall be made tight in the most approved manner. Tests shall be repeated once after leaks and defects have been repaired. When automatic control valves, equipment and similar devices which

are incapable of withstanding test pressures applied to piping, such devices shall be removed, or otherwise protected during tests. After approval of such tests, devices shall be installed and tested with operating medium to operating pressures. The following shall be tested for four consecutive hours and proved tight. Leaks shall be remedied by replacing defective work.

Item	Hydrostatic Field Test
Low pressure steam and condensate piping	100 psi
Pumped low pressure condensate returns (discharge)	100 psi
Overflow and drain	50 psi
Cold Water (domestic)	100 psi
Hot water	100 psi
Chemical Treatment	100 psi
Vent-Water discharge	100 psi

E. Leaks appearing during the various pressure tests shall be corrected by replacing all defective materials or welds and subsequent tests shall be made until the piping is found perfect. Caulking of screwed joints or pending of welds is prohibited. Wherever it is necessary to cut out a weld and the ends of the pipe cannot be conveniently brought together, then a short piece of pipe shall be fitted in and welded as approved by the Architect.

F. Provide all other tests required by the Building Department, Fire Department and all other authorities having jurisdiction.

3.02 RUNNING TEST OF PIPING SYSTEMS

A. When directed, any section of the work, after it has been completed and otherwise satisfactorily tested, shall be put in actual operation and operated for a period of two (2) days of 24 hours each, during which time any defects which may appear shall be remedied and any adjustment which may be necessary shall be made.

B. During the time of the tests, repack all valves, make all adjustments and otherwise put the apparatus in perfect condition for operation, and instruct the Owner's representative in the use and management of the apparatus.

3.03 EQUIPMENT TEST

A. Demonstrate that all equipment and apparatus fulfill the requirements of the Specifications and that all equipment shall be operated and tested for rated capacities and specified characteristics. Voltage and amperage readings shall be taken on all electric motors.

B. Operate air handlers and fans for 40 hours and demonstrate fans operating at maximum capacity.

3.04 TEST PREPARATION AND PROCEDURE

A. On initial startup, prior to any tests, check the rotation and running amperage of all fan and pump motors to prevent damage to equipment by overload.

B. Final balancing must be done with all systems completely installed and operating, and after the automatic temperature controls have had their final adjustment.

C. New, clean filters must be installed in all supply systems prior to balancing.

D. All water systems shall be completely filled and vented, and all strainers cleaned prior to balancing. Inspect expansion tanks for proper water level and operating of makeup water valves.

E. All main supply air ducts shall be traversed, using a pitot tube and manometer. The manometer shall be calibrated to read two significant figures in all velocity pressure ranges. Duct traverses shall be conducted using the log-Tchebycheff method. The equal area method is not acceptable.

F. A main duct is defined as either of the following:
   1. A duct serving five or more outlets.
   2. A duct serving two or more branch ducts.
   3. A duct serving a reheat coil.
   4. A zone duct from a multi-zone unit.
   5. A duct emanating from a fan discharge or plenum and terminating at one or more outlets.

G. The intent of this operation is to measure by traverse the total air quantity supplied by the fan and to verify the distribution of air to zones.

H. Submit data in support of all supply fan deliveries by the following four methods:
   1. By summation of the air quantity readings at all outlets.
   2. By duct traverse of main supply ducts.
   3. By a rotating vane traverse across a filter or coil bank.
   4. By plotting RPM and static pressure readings on the fan curve. Air density corrections must be indicated.

I. Inspect all fan scrolls and remove objects or debris. Inspect all coils and remove debris or obstructions. Verify that all fire dampers are open.

J. The supply air systems shall be completely balanced prior to the final balancing of the water systems.

K. Upon completion of all air and water balancing, all duct dampers, plug valves and other throttling devices shall be marked in the final adjusted position.

3.05 AIR BALANCE

A. Record the following design requirements for all fans and fan motors from the approved shop drawings.
   1. Air quantities - CFM
   2. Approximate fan speed - RPM
   3. Fan static pressure (total or external) - inches of water.
   4. Maximum tip speed - FPM
   5. Outlet velocity - FPM
   6. Fan brake horsepower
   7. Motor horsepower
   8. Volts, phases, cycles and amps at design conditions.

B. Record the following data from all fans and fan motors installed at the project:
   1. Manufacturer, model and size
   2. Motor horsepower, service factor and RPM
   3. Volts, phases, cycles and full load amps

4. Motor starter and heaters size
5. Equipment location

C. All fans and duct systems shall be completely balanced by the adjustment of sheaves, dampers, registers and other volume and diverting control devices, to obtain the air quantities indicated on the Drawings. Outside air and return air modulating dampers shall be adjusted to admit the specified quantities of air under all cycles of operation. All final adjusted air quantities shall be within 10% of the design requirements. Replace sheaves if required to meet design conditions.

D. Record the following test data for all fans and motors installed at the Project at final balanced conditions:
1. Fan speed RPM.
2. Fan static pressure (external and total) inches of water.
3. Static pressure drop across all filters, dampers, coils and other items in the supply fan casings.
4. Motor operating amps.
5. Actual voltage
6. Fan CFM
7. Calculated brake horsepower.

E. Submit single line diagrams of all duct systems indicating all terminal outlets identified by number. Data sheets shall list all such outlets denoted by the same numbers, including the outlet's size, "K" factor, location, CFM and jet velocity.

F. Submit this data for all supply, return and exhaust air systems.

G. Adjust the outside air and return air dampers to admit the required amounts of air under both summer and winter cycles. Record and submit the outside, return and mixed air temperatures for both cycles after final adjustments.

H. Air balancing shall be performed with filters partially blocked to simulate a pressure drop across the filters equal to that midway between the clean and the dirty condition.

3.06 WATER BALANCE

A. Record the following design requirements for all pumps and pump motors from the approved shop drawings:
1. Water quantity - GPM
2. Total head - feet of water
3. Pump speed - RPM
4. Impeller size
5. NPSH (if required)
6. Motor horsepower
7. Volts, phases, cycles and amps at design conditions

B. Record the following data from all pumps motors installed at the project:
1. Manufacturer, model and size.
2. Impeller size
3. Motor horsepower, service factor and RPM
4. Volts, phases, cycles and full load amps
5. Motor starter and heaters size
6. Equipment location

C. All pumps and piping systems shall be completely balanced by the adjustment of balancing valves, globe valves or other control devices, to obtain the flow quantities indicated on the Drawings. Balancing shall be done with all controls set for full flow through coils. All automatic throttling valves shall be in the full-open position. All automatic three-way valves shall have the bypass port closed.

D. Record the following test data for all pumps and pump motors installed at the Project:
   1. Pump speed - RPM
   2. Total head at shut-off or dead-end discharge - feet of water. (Plot this value on pump curve as a verification of impeller size.)
   3. Suction, discharge and total head at final adjusted flow - feet of water.

E. Balance the water flow through all heat exchangers in accordance with design requirements.

F. Flow shall be balanced through all equipment and coils by means of flow measurement and pressure drop. Obtain curves from the various manufacturers indicating the relationship between flow and pressure drop through the coils and equipment. Readings shall be taken on calibrated test gauges. Submit curves with the final report.

G. Upon completion of the water balance, reconcile the total heat transfer through all coils by recording the entering and leaving water temperatures and the entering and leaving air dry bulb and wet bulb temperatures.

H. Upon completion of balancing adjust all differential bypasses and three-way valve bypasses for the same pressure drop or full bypass as on full flow.

END OF SECTION 15900

SECTION 15950

AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section is coordinated with and complementary to the General Conditions and Special Conditions of the Work wherever applicable to Mechanical and Electrical Work.

B. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.

1.02 WORK INCLUDED

A. Work included in this section is as follows: provision of all labor, materials, equipment, accessories, services and tests necessary to complete and place into satisfactory operation a complete system of automatic temperature controls (ATC) as shown on the drawings and hereinafter specified.

B. It is the responsibility of the ATC Contractor to provide all programming of the ATC system.

C. The control system shall be of the full modulating type unless otherwise indicated, all as hereinafter specified. Control equipment shall be the product of one manufacturer. The temperature control manufacturer shall be responsible for the quality and satisfactory operation of material provided but not actually manufactured by him.

D. The control system shall include all necessary thermostats, damper motors, relays, etc., and all necessary equipment for a complete control system, regardless of whether or nor specifically mentioned, including electric relays and contactors required for control interlocking.

E. The control system shall include all control and interlock wiring from freezestats, firestats and relays, to motor controllers, contactors, etc. All control circuits shall be 120 volts.

F. Provide nameplates on all devices, whether or not mounted on the face of local control panels. In occupied areas, nameplates shall be concealed beneath covers of room type instruments, to describe functions.

G. ATC Sub-Contractor shall provide:
   1. All necessary programming, engineering, design integration and technical support with complete installation for fully operational and working systems.
   2. Complete temperature control system to be DDC with electronic actuation as specified herein.
   3. All wiring, conduit, panels, accessories for a complete operational system.
   4. ATC Sub-Contractor shall be responsible for all electrical work associated with the ATC system and as shown in the contract documents.
      a. Perform all wiring in accordance with all local and national codes.
      b. Install all line voltage wiring, concealed or exposed, in conduit in accordance with the division 16 specifications, NEC and local building code.

c. Provide extension of 120 volt, 20 amp circuits and circuit breakers from power panels for control systems as required.
d. Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers.
e. All low voltage electrical control wiring throughout the building shall be run in accordance with the division 16 specifications, local building code and the NEC.
f. Provide all miscellaneous field device mounting and interconnecting wiring for all mechanical systems including humidifiers, A/C units, condensing units, cooling towers, expansion tanks, , unit heaters, electric heaters, fans, H&V, cabinet heaters, etc.
g. All systems requiring interlock wiring shall be hardwired interlocked.

5. All stainless steel wells for water monitoring devices, flow switches and alarms, as required.
6. A complete operational system including all work specified herein, specified in associated specifications for mechanical and electrical work, shown on all contract drawings, remote function schedule, etc.
7. Provide scaled floor plans indicating equipment location, service, and system data as required by the Owner.

H. General Product Description:
1. The ATC system shall consist of the following:
a. Independent, DDC Controllers for each pump. The intent of this specification is that the loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller. Motors in motor control centers shall be controlled from DDC controller associated with HVAC system.
2. Each DDC Controller shall be modular in nature and shall permit the addition of point hardware modules in increments of two points, maximum.
3. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O and data collection. The failure of any single component or network connection (including a wire break) shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.

I. LON or BACnet Compliance:
1. Mandatory Requirement: All physical points and virtual software points (such as setpoints, loop outputs and alarm settings) shall be fully native BACnet class 3 or LON compliant. All BACnet and LON instance numbers are to be defined and documented for future open systems to connect.

1.03 RELATED WORK

A. Specified elsewhere:
1. Basic Mechanical Requirements
2. Motors
3. HVAC Pumps
4. Testing, Adjusting and Balancing
5. Basic Elec. Materials Methods
6. Electrical Wiring

1.04 QUALITY ASSURANCE

A. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

B. All portions of the system must be of the same manufacturer and must be designed, furnished, installed, commissioned and serviced by manufacturer employed, factory trained employees. Systems proposed by distributors, manufacturer's representatives, and/or independent contractors shall not be considered and are not acceptable.

C. Single source responsibility of supplier shall be the complete installation and proper operation of the ATC system and shall include debugging and proper calibration of each component in the entire system.

D. Supplier shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

F. Every DDC controller shall be provided with local operator keypad display as specified herein to permit monitoring and setpoint adjustment locally for each system controlled.

G. All system components to be fault-tolerant.
   1. Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3 Hertz variation in line frequency.
   2. Static, transient and short-circuit protection on all inputs and outputs.
   3. Protect communication lines against incorrect wiring, static transients and induced magnetic interference.
   4. Network-connected devices to be A.C. coupled or equivalent so that any single device failure will not disrupt or halt network communication.
   5. All real time clocks and data file RAM to be battery-backed for a minimum 100 hours and include local and remote system low battery indication.

H. Manufacturer and installer shall meet the following qualifications:
   1. A minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of DDC systems similar in size and complexity to this project.
   2. A maintained service organization consisting of at least ten (10) competent servicemen, within 50 miles of the project site, for a period of not less than ten years.
   3. The manufacturer/installer shall not be considered qualified to bid this project unless they can provide a list of 10 projects, similar in size and scope to this project, completed within the last five years.
   4. Manufacturer and installer shall be required to furnish at least three client references of installations of similar scope and complexity as specify under this contract. References shall be for protects completed within the past five (5) years. References shall be submitted within thirty (30) days of contract award. Failure to meet the aforementioned requirements shall provide grounds for reflection of proposed ATC system manufacturer or installer.

I. The manufacturer/installer shall provide a full time, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the ATC system.

J. Comply with all current governing codes, ordinances, and regulations including UL, NFPA, the local Building Code, NEC, etc.

K. The manufacturer and installer of the building management system shall provide documentation supporting compliance with ISO-9001 (model for Quality Assurance in Production, Installation and Servicing). The intent of this specification requirement is to ensure that the products and services that the manufacturer and installer provide are delivered through a Quality System and Framework that will assure consistent quality throughout the project.

L. The system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade the existing field panels to the latest technology and being able to install the newest field panel on the existing network without bridges, routers, protocol converters or gateways.

1.05 ACCEPTABLE MANUFACTURER/INSTALLERS

A. Automated Logic Corporation

B. Allerton Technologies

C. Andover Controls

D. Trane Controls

E. Or approved equal

1.06 SUBMITTALS

A. General
1. Indicate at the beginning of each submittal, known substitutions and deviations from requirements of Contract Documents.

B. Product Data
1. Technical bulletins and catalog data for all equipment and system components. Clearly identify, by use of symbol or tag number, the service of each item. All irrelevant information shall be marked out leaving only pertinent data.

C. Shop Drawings
1. Shop drawing submittals to comply with specified requirements and include sufficient data to indicate complete compliance with Contract Documents. Submission in form of drawings, brochures, bulletins, catalog data, and/or narrative descriptions.

D. Within thirty (30) days of award of contract manufacturer shall provide schedule of all submittals employing format as provided hereinafter and enumerating all drawings, samples and miscellaneous submittals by name, quantity, etc.

E. Allow six (6) weeks for shop drawing review by Engineer.

1.07 OWNER'S MANUALS

A. General
   1. Submit two (2) draft copies of Owner's manuals for review. After review by authorized representative, the Contractor shall incorporate review comments and submit four (4) interim final copies. Upon completion of project, acceptance of project by the Owner, submit six (6) copies of final "as built" manuals and one (1) reproducible copy (3-mil sepia mylar).
   2. Update manuals with modifications made to system during guarantee period. Provide replacement pages or supplements in quantity stated above for "as built" manuals.

B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
   1. Control flow diagrams for all building systems.
   2. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross reference the system point names.
   3. Description of manual override operation of all control points in system.
   4. ATC system manufacturer's complete operating manuals.

C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:
   1. Complete as-built installation drawings for each building system.
   2. Overall system electrical power supply scheme indicating source of electrical power for each system component. Indicate all battery backup provisions.
   3. Overall system shielding and grounding scheme indicating all major components and ground paths.

D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:
   1. Complete programming manuals, and reference guides.
   2. Details of any special software packages and compilers supplied with system.
   3. Information required for independent programming of system.
   4. Point schedule; include all points, real and virtual.
   5. Software troubleshooting procedures.

E. Allow six (6) weeks for Architect/Engineer review of shop drawings.

1.08 WARRANTY

A. The Contractor shall warranty the ATC system to be free from defects in workmanship and material for a period of one (1) year from the date of acceptance by the Owner. During this period, the Contractor shall furnish all labor, parts, materials and equipment to repair or replace all items or components which fail due to defects in workmanship or material. This Contractor shall also provide all system software upgrades during the warranty period.

B. Installer and manufacturer shall provide 24 hours/365 days telephone numbers for service calls, E-mail addresses and fax numbers of installer and manufacturer officers to be contacted for service calls. The Contractor shall submit a written report within 2 days of all warranty defects, the action taken and corrections made for each warranty call.

C. Contractor shall be required, as part of its obligation under the warranty to respond to service calls within twelve (12) hours of being notified via telephone, E-mail or fax transmittal.

1.09 TRAINING

A. The Contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed rather than a general training course. Training shall include all aspects, elements and components of the system, including hardware and software. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays.

B. Provide 40 hours of training for Owner's operating personnel.

C. Provide 8 hours of additional training quarterly during warranty period.

D. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If such training is required by the Owner, it will be contracted at a later date. Provide description of available local and factory customer training.

1.10 SERVICE CONTRACT

A. Include full preventive maintenance (PM) contract included in this bid covering all parts, materials, software, hardware, and all costs to provide software and hardware upgrades during the warranty period. The preventive maintenance shall include the greater of one eight (8) hour on site PM days per month or the manufacturers required time to complete full PM. Turnover PM contract stamped "Paid In Full" at start upon Owner's request. Provide for 24 hour, 7 day per week response to emergency calls. Response shall be within twelve (12) hours by phone, E-mail and/or fax transmittal/notification.

1.11 ALTERNATE PRICING

A. The HVAC Sub-Contractor has the option of having the rooftop packaged 100% outside air conditioning unit for the corridors automatic temperature controls be provided by the rooftop unit manufacturer or the automatic temperature control building automation system Sub-Contractor. ATC under Section 15950.

B. Controls provided under Section 15950 shall be shipped to the rooftop AC unit manufacturer for installation (mounting & wiring) in the AC unit at the factory.

C. The ATC Sub-Contractor shall provide alternate pricing to the HVAC Sub-Contractor for the AC Unit controls.

D. Provide alternate price for networking of DDC controllers provided under this contract.

PART 2 - PRODUCTS

2.01 SYSTEM OVERVIEW

A. The ATC system Sub-Contractor shall provide system software based on a server/thin-client architecture

B. Software Components
All software components of the ATC system software shall be installed and completed in accordance with the specification. ATC system components shall include:

1. System Configuration Utilities for future modifications to the system
2. Direct digital control software
3. Application Software

2.02 LOCAL OPERATOR KEYPAD DISPLAY

A. Local Keypad Display (LOK)

1. General Purpose Controller Plug-in. Keypad and display shall be provided on face of each local control panel at each system controlled. The LOK shall plug directly into any general purpose/multi application controller and enable maintenance personnel to access and modify specified building control parameters in any DDC control panel.
2. Interface. The LOK shall comprise a minimum of four function keys and employ a backlit display for easy reading in poor lighting conditions. Each function key shall act as a 'hot-key' to menus comprised of control parameters. The display shall utilize English language descriptors rather than cryptic code and a menu penetration technique to access data. Clearly marked 'up' and 'down' arrow keys shall be used to move between point descriptors listed in each menu. The LOK backlit display shall be 4 by 40 characters. Model BAC View 2 by Automated Logic or AViewport@ BT-1 by Alerton Technologies or approved equal.
3. Menu Language. The English language menus in the LOK shall be constructed using industry standard HTML. Access to building control parameters shall be protected by password entry.

2.03 DDC SOFTWARE - OVERVIEW

The system shall continuously perform Direct Digital Control (DDC) functions at the local control module in a stand-alone mode. The operator shall be able to design and modify the control loops to meet the requirements of the system being operated. The operators shall use system provided displays for tuning of PID loops. These displays shall include the past three input variable values, the setpoint for the loop as well as the sample interval and the results of the proportional, integral and derivative effects on the final output.

A. Minimum Function

Each control module shall perform the following functions:

1. Identify and report alarm conditions
2. Execute all application programs indicated on the I/O Summary table
3. Execute DDC algorithms
4. Locally trend and store data

B. Control Failure Mode

In the event of a control module failure, all points under its control shall be commanded to the failure mode as indicated on the I/O Summary Table. All DDC software shall reside in the respective control module.

1. Orderly Shutdown. Power failures shall cause the control module to go into an orderly shutdown with no loss of program memory.
2. Automatic Restart. Upon resumption of power, the control module shall automatically restart and print out the time and date of the power failure and restoration at the respective Workstation system.
3. Automatic Restart. The restart program shall automatically restart affected field equipment. The operator shall be able to define an automatic power up time delay for each piece of equipment under control.

2.04 APPLICATIONS SOFTWARE - GENERAL

The following applications software shall be provided for the purpose of optimizing energy consumption while maintaining occupant comfort:

A. Time of Day Scheduling (TOD)

The system shall be capable of the following scheduling features:

1. Schedule by Type. Scheduling by building, area, zone, groups of zones, individually controlled equipment and groups of individually controlled equipment. Each schedule shall provide beginning and ending dates and times (hours: minutes). A weekly repeating schedule, i.e. between 8:00 a.m. and 5:00 p.m., Monday through Friday shall constitute one schedule, not five.
2. Schedule in Advance. Dated schedules shall be entered up to 9 (nine) years in advance.
3. Self-Deleting. Schedules shall be self-deleting when effective dates have passed.
4. Leap Year. Leap years shall be adjusted automatically without operator intervention.

B. Optimum Start/Stop (OSS)/Optimum Enable/Disable (OED)

This application provides software to start and stop equipment on a sliding schedule based on the individual zone temperature and the heating/cooling capacity in EF/hour of the equipment serving that zone. The heating/cooling capacity value shall be operator adjustable. Temperature compensated peak demand limiting shall remain in effect during morning start up to avoid setting a demand peak.

C. Source Temperature Optimization (STO)

The system shall automatically perform source optimization for all air conditioning units, air handling units and heat exchangers in response to the needs of other downstream pieces of equipment, by increasing or decreasing supply temperature setpoints, i.e. condenser water, discharge air, etc. using Owner defined parameters. In addition to optimization, the STO capability shall also provide for starting and stopping primary mechanical equipment based on zone occupancy and/or zone load conditions.

1. Setpoint Reset. The STO program will allow setpoints for various equipment in the heating/cooling chain to be reset between an operator defined maximum and a minimum setpoint based on the actual requirements of the building zones. The actual setpoint shall be calculated based on the number of heating or cooling requests which are currently being received from the equipment or zones served. Once every update period, the STO program surveys the network to see if any piece of equipment requires any additional heating or cooling from its source. As an example, a VAV air handler is the source of cold air for a number of VAV boxes. Assume that the STO program for the air handler has the following parameters established for it by the Owner:

   Optimized setpoint description B

   a. Initial setpoint is 60.00,
   b. Max. setpoint is 65.00,
   c. Min. setpoint is 55.00.
   d. Every 2.0 mins, trim by 0.25 and respond by -0.50 but no more than 2.0.

   Every two minutes, the STO program will total up all of the requests and calculate a new setpoint:

   New setpoint = prev setpoint + 'trim by' + ('respond by' x m of req.). Assuming four requests were received and the previous setpoint was 57.00 degrees, the new setpoint would be:

   New setpoint = 57.00 + 0.25 + (-0.50 x 4) = 55.25 EF

If (the number of requests received) x (the 'respond by' value) > (the 'but no more than' value), use the 'but no more than' value inside the parenthesis in the above calculation.

D. Day/Night Setback (DNS)

The system shall allow the space temperature to drift down [up] within a preset [adjustable] unoccupied temperature range. The heating [cooling] shall be activated upon reaching either end of the DNS range and shall remain activated until the space temperature returns to the DNS range.

1. Outside & Exhaust Air. The system shall be capable of closing all outside air and exhaust air dampers during the unoccupied period, except for 100% outside air units.
2. Unoccupied Space Temperature. Unoccupied space temperature shall be monitored by the DDC temperature sensors located in the individual zones being controlled or within a representative room.
3. Parameter Changes. Operator shall be able to define, modify or delete the following parameters.
   a. DNS setpoint temperature(s)
   b. Temperature band for night heating operation
   c. Period when the DNS is to be activated

E. Space Temperature Control (STC)

There shall be two space temperature setpoints, one for cooling and one for heating, separated by a dead band. Only one of the two setpoints shall be operative at any time. The cooling setpoint is operative if the actual space temperature has more recently been equal to or greater than the cooling setpoint. The heating setpoint is operative if the actual space temperature has more recently been equal to or less than the heating setpoint. There are two modes of operation for the setpoints, one for the occupied mode (example: heating = 72EF or 22EC, cooling = 76EF or 24.4EC) and one for the unoccupied mode (example: heating = 55EF or 12.7EC, cooling = 90EF or 32EC).

1. Schedule. The occupied/unoccupied modes may be scheduled by time, date, or day of week.
2. PID Loop. A PID control loop, comparing the actual space temperature to its setpoint, shall modulate the dampers [and heating coil valve or heating stages in sequence] to achieve the setpoint target.

2.05 FIELD DEVICES

A. All devices and equipment shall be approved for installation.

B. All control signals shall be via a 4-20 mA loop.

C. Temperature Sensors

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. All temperature sensor shall use platinum RTD elements or 10K OHM thermistors. All control signals shall be via a 4-20 mA loop.
2. Room Temperature

Temperature monitoring range	+40/+90 F
Output signal	4-20 mAdc
Installation adjustments	none required
Calibration adjustments	zero & span
Factory calibration point	70 EF
Accuracy at calibration point	+0.5 F

3. Liquid Immersion Temperature

Temperature monitoring range	+20/+120 F +70/+220 F
Output signal	4-20 ma
Installation adjustment	none required
Calibration adjustments	zero & span
Factory calibration point	70 EF
Accuracy at calibration point	+0.5 F

Furnish stainless steel wells with extension neck for insulation

4. Duct (Single Point) Temperature

Temperature monitoring range	+20/+120 F +70/+220 F
Output signal	4-20 mAdc
Installation adjustments	none required
Calibration adjustments	zero & span
Factory calibration point	70 EF
Accuracy at calibration point	+0.5 F

5. Duct (Averaging) Temperature

Temperature monitoring range	+20/+120 F
Output signal	4 - 20 mA DC
Installation adjustments	none required
Calibration adjustments	zero & span
Factory calibration point	70 EF
Accuracy at calibration point	+0.5 F

Provide for locations upstream of supply fan, e.g. mixed air, heating and cooling coils.

6. Outside Air Temperature

Temperature monitoring range	-50/+122
Output signal	4-20 mAdc
Installation adjustments	none required
Calibration adjustments	zero & span
Factory calibration point	70 EF
Accuracy at calibration point	+0.5 F

D. Dew Point/humidity Sensors

1. Outside Air Dew Point Temperature

Dew point monitoring range	-40/+115 F DP, 12% to 99% RH
Output signal	4-20 mA
Calibration adjustments	zero & span
Factory calibration point	70 F
Accuracy at calibration point	+2.0 Fdp

E. Pressure Sensors

1. Water Differential Pressure Switch

Range	8 to 70 psi
Differential	3 psi
Maximum differential pressure	200 psi
Maximum pressure	325 psi

2. Water Pressure Sensor

a. Provide industrial grade pressure sensors. Sensor shall be factory calibrated for operating range and rated for system pressure. Provide manufacturers standard 316 stainless steel, 3 valve manifold and pressure gauges. Output shall be 4-20 ma.

F. Automatic Control Valves

1. All automatic control valves shall be fully proportioning with modulating plug or V-port inner valves, ANSI 250, unless specified otherwise. The valves shall be quiet in operation and fail-safe in either normally open or normally closed position in the event of power failure. The valves shall be capable of operating in sequence with other valves and/or dampers when required by the sequence of operation. All control valves shall be sized by the control manufacturer and shall be guaranteed to meet the heating and cooling loads as scheduled. All control valves shall be suitable for the pressure conditions and shall close against the differential pressures involved. Valve operators shall be of the electric spring return type. Body pressure rating and connection type construction shall conform to fitting and valve schedules. Control valve operators shall be sized to close against a differential pressure equal to the design pump head plus 10 percent. Where pressure and flow combinations exceed ratings for commercial valves and operators, industrial class valves and operators shall be provided.
2. All steam control valves shall be single seated. No single steam valve shall be larger than 2-1/2". Whenever the flow rate is such as to require a valve larger than 2-1/2", then two valves in parallel shall be used, with no one larger than 2-1/2". The valves shall operate sequentially. Trim shall be stainless steel.
3. Furnish differential pressure control valves for all water systems where modulating water flow conditions are required to prevent excessive pump pressure build-up. Provide a valve for the closed loop condenser water and chilled water systems. Valve to be globe type. Provide valves 2" and smaller with screwed end bodies and provide valves 2-1/2" and larger with flanged ends.

G. Electric Thermostats

1. Furnish and install all line voltage thermostats for unit heaters. Thermostats contacts shall be rated for maximum heater amperage and shall be snap acting, SPDT. Thermostat cover shall provide exposed set point and key adjust.
2. Furnish and install strap on aquastats to prevent unit heaters from operating without heat available.

H. Component Tags

1. All automatic and manual valves provided by this Contractor, shall be identified with 2" diameter brass tags and brass chains. Lettering shall be 2" high, stamped and painted black. Automatic valve tags shall be stamped with the letters "AV" and sequentially numbered. Provide valve schedule and sample tags for approval.
2. All sensors shall be identified with 1"x 3" black lamacoid labels with engraved white lettering. Lettering shall be 3" high. Provide sensor number, HVAC Unit number, part number and sensor range on tag. Submit tag schedule and sample for approval.
3. All panels, auxiliary component panels, transformer panels, etc. provided by this Contractor, shall be identified with 2"x 5" black lamacoid labels with engraved white lettering. Lettering shall be 2" high. Provide panel number, HVAC Unit number and service on tag. Submit tag schedule and sample for approval.
4. All automatic dampers provided by this Contractor, shall be identified with 2" diameter brass tags and brass chains. Lettering shall be 2" high, stamped and painted black. Tags shall be stamped with the letters "AD" and sequentially numbered. Provide damper schedule and sample tags for approval.

I. Local Panels & Enclosures

1. Provide adjacent to each air supply unit and each mechanical system (air, water and glycol systems), as herein specified, enclosed local control panels of 14 gauge steel or Formica set in an extruded aluminum frame, with welded angle iron brackets,

wall or floor type, and with hinged locked door, in which shall be mounted the associated temperature, humidity and pressure controls, relays, etc., and on which shall be flush mounted the associated switches, air gauges, thermometers, etc., as previously and hereinafter described. The basic background color of the panel shall be as approved by the Engineer.

2. Panels for rooftop air handlers and AC units shall be located in compartments provided in the rooftop air handler. Coordinate space requirements with the rooftop air handler/AC unit.
3. Details of each panel shall be submitted for approval prior to fabrication. Locations of each local panel provided are to be convenient for adjustment and service and within five (5) feet of system motor. All such locations are to be approved prior to installation. Provide engraved nameplates beneath each panel face mounted control device and air gauge, clearly describing the function of said device and the range of operation. Provide a removable laminated or engraved color coded graphic system illustration 20" x 12" minimum size on each panel face. Provide a common key for all local panels. Provide and wire a 15 watt fluorescent light canopy, with switch, for each panel, to terminal strip in control panel.
4. Instrumentation within the panel shall be identified. All electrical components within the panel shall be factory pre-wired to a numbered terminal strip. All wiring within the panel shall be in accordance with NEMA and UL standards and shall meet local codes.
5. All controllers installed outside of the building shall be provided with NEMA 3 weatherproof enclosures.
6. All transformers, electric relays, static pressure sensors, velocity pressure sensors, manual override switches, etc., shall be mounted in local panels and factory wired to terminal strips.

J. Master Outside Air Temperature Transmitter

1. Master outside air transmitters shall be provided, for indicating outside air temperature as part of the ATC system. Remote outdoor location shall be submitted for approval.
2. The sensing element shall be located in an aspirator box on north face of each building or so located to insure air circulation over the element and produce an accurate signal corresponding to the outdoor air temperature.

K. INSTALLATION

1. Install airflow probes and transducers at locations indicated on the drawings and in accordance with manufacturer's installation instructions.
2. Install monitor electronics at locations indicated on the drawings and in accordance with manufacturer's installation instructions.
3. Install probes such that pressure connections are at the top of the mounted probe. Probes should be installed such that the best coverage or area being measured can be achieved. Factory assistance shall be available.
4. Install the transducer such that it is located at a slightly higher elevation than the highest probe=s ports. Transducer shall be mounted so that the pressure connections are on the bottom of the enclosure. Connecting tubing should be pitched downward and away from the transducer so that any accumulated moisture can drain back towards the probe. Tubing should be installed so that there are no pockets where moisture might accumulate.
5. Cable connecting the transducer and monitor shall be installed in a neat and workmanlike manner. Penetrations through the air handler walls shall provide some means to prevent chafe.

L. Electric Valve Operators

1. All electric operators shall be of totally enclosed type in rustproof housings of pressed steel or approved cast metal. An open type gear train will not be acceptable. All operators shall be of the spring return type, to provide failsafe operation and overtravel protection. Each automatic damper shall be provided with a separate damper operator. Operators to be located outdoors shall be NEMA 3R rated. All electric operators shall be as manufactured by Belimo.
    a. Electronic actuation shall be provided using Belimo actuators.
    b. The actuator shall be Belimo type direct coupled (over the shaft), enabling it to be mounted directly to the damper or valve shaft without the need for connecting linkage. The fastening clamp shall use a ?V" bolt and ?V" shaped, toothed cradle to attach to the damper shaft for maximum holding strength. Single bolt or set screw type fasteners are not acceptable.
    c. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator at the end of rotation or magnetic clutch are not acceptable.
    d. For power failure/safety applications, a mechanical, spring return mechanism shall be used. Non-mechanical forms of fail-safe are not acceptable except for a central, emergency, backup power source.
    e. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by changing the mounting orientation. Spring return actuators should be capable of mounting directly onto a jackshaft up to 1.05" in diameter.
    f. Proportional actuators shall accept a 2 to 10 VDC or 4 to 20 mA and provide a 2 to 10 VDC position feedback signal.
    g. 24 VAC/DC actuators shall not require more than 10 VA for A/C or 8 watts for DC applications.
    h. All actuators shall have an external manual gear release or manual crank to aid in installation and allow manual positioning when the actuator is not powered.
    i. All actuators shall have an external direction of rotation switch to aid in installation and provide proper control response.
    j. Actuators shall be provided with a factory mounted 3-foot electrical cable and conduit fitting to provide easy hook up to an electrical junction box.
    k. The actuators shall be listed under Underwriters Laboratories Standard 873 and Canadian Standards Association Class 813.02. They must be manufactured under ISO 9001 quality certification.
    l. Actuators shall have a 2-year manufacturer=s warranty, starting from the date of installation.

M. Temperature Transmitters
1. All temperature transmitters shall be capable of measuring space or duct temperature or humidity and transmitting an electric signal (4 to 20 MA) directly proportional to the temperature. Temperature transmitter shall be of the platinum RTD type. The range of the temperature transmitters shall be 50EF. for room air sensing, and 100EF. or 200EF. for all other sensing, as approved. All humidity transmitters shall have a range of 80% RH. Each transmission system shall have an accuracy of 1% of scale range. All transmitters shall be located at point of measurement, with instrument case located outside of unit or ductwork with capillaries and sensing bulbs as described above for thermostats. Room transmitters shall have casings as described for room thermostats. Finish and final location of room transmitters shall be approved by the Architect.
2. Transmitters shall be 60/70 series as manufactured by Vaisala or as manufactured by Fisher-Rosemount.

3. Transmitter shall provide one point field calibration for both RH and temperature.
4. Temperature accuracy shall be 0.5EC in the -5EC to 50EC temperature range.
5. Wall mount housing shall be ABS plastic (color to be selected by the Architect.) Duct mounted housing shall be cast aluminum. Duct mounted sensor protection shall be stainless steel.
6. Provide two Vaisala HIM 41 humidity calibrators and two equivalent temperature calibrators to allow facility staff to check & calibrate transmitters.
7. Wall mounted temperature and humidity transmitters shall be provided with heavy duty guards of lexan or cast aluminum. Submit samples for review.
8. Where temperature and humidity transmitters are in same room, provide both under one wall mounted housing or cover.

N. Temperature Transmitters
1. Transmitters shall be of 2-wire, 4-20 mA output type with a solid state or RTD type element having an accuracy of ∀1% of span. Transmitter shall include protection against reverse polarity and supply voltage transients. A span and zero adjustment shall be provided with each transmitter to allow for recalibration as necessary.
   a. Room sensors
      1) Sensor covers shall be provided with tamper resistant screws, and heavy duty guards.
   b. Duct sensors
      1) Single point duct mounted sensors shall have a minimum 9" rigid probe and be used when the duct size is less than 24".
      2) Averaging duct mounted sensors shall have a minimum 12.5' long averaging element and be used when the duct size is greater than 24".
   c. Well sensors
      1) Liquid immersion sensors shall have a stainless steel probe and a stainless steel well. Length of the sensor well shall be selected based on the diameter of the pipe to provide accurate, reliable sensing of the liquid temperature. Provide well with lag extension equal to depth of pipe insulation.
   d. Outside sensors
      1) Sensing elements shall be mounted in aspirator box as per master outside air transmitter section above.

O. Flow Transmitters
1. Airflow
   a. The sensor shall be a 4-20 mA output type with the accuracy of ∀1% with flow straighteners in circular duct applications. In rectangular duct applications, the accuracy shall be ∀2% with flow straighteners.
   b. Velocity range of 100 to 10,000 FPM air at STP.
   c. Flow station shall be constructed of steel with flanged face for easy mounting. The flow straighteners shall be constructed of aluminum or steel.
   d. Approved manufacturer: Tek-Air or Air Monitor.
2. Liquid flow
   a. The sensor shall be 4-20 mA output type with the repeatability of ∀0.1% of value.
   b. Temperature limits: -20.0E to 850.0EF., range 0-50" WC.
   c. Material is dependent upon that of the size and type of pipe material.
   d. Install across flowmeter provided by HVAC Contractor.

P. Liquid Proving Switches

1. The proving switch shall measure the difference in pressure exerted upon its sensing elements and operate a SPDT switch at the differential pressure setpoint.
2. The differential pressure setpoint must be adjustable between the ranges of 8-60 psig and the switch differential shall be 1.5 psi.
3. Approved manufacturer: Penn A-74 series or equivalent.

Q. Water Pressure Transmitter

1. A set of water pressure transmitters shall be provided to transmit to the BAS the pressure in the supply and return lines for each of the various hot water, and chilled water systems which require differential pressure control by modulating differential control valves and or pump variable frequency drives. The BAS shall be programmed to read and accept the two transmitter signals and use them to determine differential pressure and provide differential setpoint control. Pressure transmitters shall be RE Technologies Model PTN.
   a. Range 0-150 psig or as required
   b. Output 4-20 mA
   c. Accuracy ∀1% full scale
   d. Maximum pressure 200%
   e. Supply voltage 10 to 30 VDC at 25 mA
   f. Case material 304 stainless steel
   g. Diaphragm 17-4 pH stainless steel

R. Control Transformers

1. A 120/24 VAC control transformer shall be provided in each DDC control panel, application specific controller panel to power the DDC equipment and controllers located therein. Common transformers serving more than one dedicated panel shall not be allowed. Transformers shall be UL listed, properly fused to protect DDC equipment and sized by the controls Contractor. For equipment requiring 24 VDC power, provide similar transformer converter as required to power the DDC equipment.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine location where controls and equipment are to be installed and determine space conditions and notify Engineer in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that equipment comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of equipment with other components of systems.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of the automatic temperature control system and after motors have been energized with normal power source, test system to demonstrate compliance with requirement. When possible, field correct

malfunctioning controls then retest to demonstrate compliance. Replace controls which cannot be satisfactorily corrected. Refer to Section - Test and Balancing.

3.04 SERVICE

A. After completion of the control system installation, the control manufacturer shall regulate and adjust all thermostats, control valves, damper motors, etc., and place in complete operating condition, subject to the approval of the Engineer. Complete instructions shall be given to the operating personnel. There shall be two day's instruction given for Winter cycle and two day's instruction for Summer cycle operation.

3.05 AUTOMATIC TEMPERATURE CONTROL SYSTEM - GENERAL

A. Space mounted devices are to be identical in appearance. All devices shall be mounted under the same style cover.

B. Provide all relays, switches, sources of electricity and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the sequences specified.

C. Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.

D. Mount surface-mounted control devices, tubing and raceways on brackets to clear the final finished surface on insulation.

E. Conceal control conduit and wiring in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90 degree angles.

F. Install control valves horizontally with the power unit up. Installation of control valves will be by the piping Contractor.

G. Unless otherwise noted, install wall mounted sensors, thermostats and humidistats at 4'-0" above the finished floor measured to the center line of the instrument. Room devices are to be of the concealed type without indicator. Submit device locations, mounting heights and details for approval. Submit floor plans showing all space and room device locations for approval whether shown on plans or not.

H. Install outdoor thermostats in perforated tube and sun shield.

I. General System Requirements
   1. Normal (no signal or electricity) positions for controlled components:
      a. Hot Water Valves - Closed
      b. Reheat Valves - Closed
   2. The ATC System shall be programmed to start and stop the HVAC equipment based on occupancy schedules coordinated with the Owner. The ATC system Sub-Contractor shall also provide equipment interlocks as required.
   3. All control dampers that are sequenced shall be provided with dedicated analog outputs.
   4. Emergency Override Stop
      a. Each AC unit and AHU-1 shall be provided with supply air duct mounted smoke detectors which shall shut down their respective supply fans upon sensing smoke.

b. All relays, electrical wiring, panels, outputs, etc. to make a complete operational system, shall be provided and installed by this section.
c. See sequences of operation for details.

5. All safeties shall be automatically reset from ATC system.
6. All set points shall be adjustable from ATC console via single point commands.
7. All reset schedule parameters shall be adjustable from ATC system console via single point commands.

3.06 ELECTRICAL WIRING AND MATERIALS

A. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. All wiring shall be installed in conduit in accordance with the Division 16 specifications.

B. Provide wiring between thermostats, aquastats and unit heater motors, all control and alarm wiring for all control and alarm devices for all Sections of Specifications.

C. Provide conduit and wiring between the ATC panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring.

D. Provide conduit and control wiring for devices specified in this Section.

E. Provide conduit and signal wiring between motor starters and motor control centers and high and/or low temperature relay contacts and remote relays in ATC panels located in the vicinity of motor control centers and starters.

F. Provide conduit and wiring between the electrical panels, indicating devices, miscellaneous alarm points, remotely operated contactors, and ATC panels.

G. All wiring to be compliant to local building code, the NEC and Division 16 specifications.

H. Provide electrical wall box and conduit sleeve for all wall mounted devices.

3.07 PERFORMANCE

A. Unless stated otherwise, control temperatures within plus or minus 2^{o}F humidity within plus or minus 3% of the set point and static pressure within 4% of set point.

3.08 COMMISSIONING, TESTING AND ACCEPTANCE

A. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets which shall be submitted prior to acceptance testing. Commissioning work which requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the Owner and Engineer to ensure systems are available when needed. Notify the University in writing of the testing schedule so that authorized personnel from the Owner and Engineer are present throughout the commissioning procedure.

1. Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications and approved shop drawings. Test, calibrate and bring on line each control sensor and device. Commissioning to include, but not be limited to:
   a. Sensor accuracy at 10, 50 and 90% of range.

b. Sensor range.
c. Verify analog limit and binary alarm reporting.
d. Point value reporting.
e. Binary alarm and switch settings.
f. Actuator and positioner spring ranges.
g. Fail safe operation on loss of control signal, pneumatic air, electric power, network communications, etc.

B. After control devices have been commissioned (i.e. calibrated, tested and signed off), each DDC programmed sequence of operation shall be put on line and commissioned. The Contractor shall submit to the Owner and Engineer, each programmed sequence of operation and comparison field test results in writing. For all controlled equipment, e.g., air handling units, heat exchangers, chillers and cooling towers, terminal equipment, etc. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracy's. System program test results shall be recorded on commissioning data sheets and submitted for Engineer's review. Any discrepancies between the specification and the actual performance will be immediately rectified and retested.

C. After all DDC programs have been commissioned, the Contractor shall verify the overall system performance as specified. Tests shall include, but not be limited to:
1. Data communication, both normal and failure modes.
2. Fully loaded system response time.
3. Impact of component failures on system performance and system operation.
4. Time/Date changes.
5. End of month/ end of year operation.
6. Season changeover.
7. System backup and reloading.
8. System status displays.
9. Diagnostic functions.
10. Power failure routines.
11. Battery backup.
12. Testing of all electrical and HVAC systems with other division of work.

D. Sub Systems not controlled by DDC shall also be tested and commissioned.

E. Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracy's and the system performance does not degrade over time.

F. Using the commissioning test data sheets, the Contractor shall demonstrate each point type, as randomly selected by the Engineer and Owner. The Contractor shall also demonstrate all sequences of operation and system functions, as randomly selected by the Engineer and Owner. Based on the above samples, the Engineer and Owner may accept the entire system or require the Contractor to demonstrate all points and system functions until all devices and functions meet specification.

G. The Contractor shall supply all instruments for testing and turn over same to the Owner after acceptance testing.
1. All test instruments shall be submitted for approval.
Test Instrument Accuracy:
Temperature: 1/4F or 2% full scale, whichever is less.

Pressure:	High Pressure (psi):	2 psi or 2% full scale, whichever is less.
	Low Pressure:	2% of full scale (in w.c.)
Electrical:	3% full scale	

H. After the above tests are complete and the system is demonstrated to be functioning as specified, a thirty day performance test period shall begin. If the system performs as specified throughout the test period, requiring only routine maintenance, the system shall be accepted. If the system fails during the test, and cannot be fully corrected within eight hours, the Owner may request that performance tests be repeated.

I. Additional testing, debugging and fine tuning
   1. Provide an additional 40 overtime hours of appropriate highest labor cost category to be used at the Owner's discretion to test, debug and fine tune the system after occupancy.
   2. The ATC sub-contractor shall submit completed commissioning reports to the Engineer prior to field demonstration of the Automatic Control Systems to the Engineer.

END OF SECTION 15950