DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING

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SECTION 23 0501 – COMMON HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Furnish labor, materials, and equipment necessary for completion of work as described in Contract Documents.

B. It is the intent of these specifications that the systems specified herein are to be complete and operational before being turned over to the owner. During the bidding process, the contractor is to ask questions or call to the engineer's attention any items that are not shown or may be required to make the system complete and operational. Once the project is bid and the contractor has accepted the contract, it is his responsibility to furnish and install all equipment and parts necessary to provide a complete and operational system without additional cost to the owner.

C. Furnish and install fire stopping materials to seal penetrations through fire rated structures and draft stops.

D. Includes But Not Limited To:
   1. General procedures and requirements for HVAC.

E. Related Sections:
   1. Section 23 0593: Testing, Adjusting, and Balancing for HVAC.

1.3 SUBMITTALS

A. Substitutions: By specific designation and description, standards are established for specialties and equipment. Other makes of specialties and equipment of equal quality will be considered provided such proposed substitutions are submitted to the Architect for his approval, complete with specification data showing how it meets the specifications, at least 5 working days prior to bid opening. A list of approved substitutions will be published as an addendum.
   1. Submit a single copy of Manufacturer's catalog data including Manufacturer's complete specification for each proposed substitution.
   2. The Architect or Engineer is to be the sole judge as to the quality of any material offered as an equal.

B. Product Data, Shop Drawings: Within 30 days after award of contract, submit 10 sets of Manufacturer's catalog data for each manufactured item.
   1. Literature shall include enough information to show complete compliance with Contract Document requirements.
   2. Mark literature to indicate specific item with applicable data underlined.
   3. Information shall include but not be limited to capacities, ratings, type of material used, guarantee, and such dimensions as are necessary to check space requirements.

4. When accepted, submittal shall be an addition to Contract Documents and shall be in equal force. No variation shall be permitted.
5. Even though the submittals have been accepted by the Engineer, it does not relieve the contractor from meeting all of the requirements of the plans and specifications and providing a complete and operational system.

C. Drawings of Record: One complete sets of blue line mechanical drawings shall be provided for the purpose of showing a complete picture of the work as actually installed.
1. These drawings shall serve as work progress report sheets. Contractor shall make notations neat and legible therein daily as the work proceeds.
2. The drawings shall be kept at the job at a location designated by the Mechanical Engineer.
3. At completion of the project these "as-built" drawings shall be signed by the Contractor, dated, and returned to the Architect.

D. Operating Instructions and Service Manual: The Mechanical Contractor shall prepare 2 copies of an Operation and Maintenance Manual for all mechanical systems and equipment used in this project. Manuals shall be bound in hard-backed binders and the front cover and spine of each binder shall indicate the name and location of the project. Use plastic tab indexes for all sections. Provide a section for each different type of equipment item. The following items shall be included in the manual, together with any other pertinent data. This list is not complete and is to be used as a guide.
1. Provide a master index at the beginning of the manual showing all items included.
2. The first section of the manual shall contain:
   a. Names, addresses, and telephone numbers of Architect, Mechanical Engineer, Electrical Engineer, General Contractor, Plumbing Contractor, Sheet Metal Contractor, and Temperature Control Contractor.
   b. List of Suppliers which shall include a complete list of each piece of equipment used with the name, address, and telephone number of vendor.
   c. General Description of Systems including –
      1) Location of all major equipment
      2) Description of the various mechanical systems
      3) Description of operation and control of the mechanical systems
      4) Suggested maintenance schedule
   d. Copy of contractor's written warranty
3. Provide a copy of approved submittal literature for each piece of equipment.
4. Provide maintenance and operation literature published by the manufacturer for each piece of equipment which includes: oiling, lubrication and greasing data; belt sizes, types and lengths; wiring diagrams; step-by-step procedure to follow in putting each piece of mechanical equipment in operation.
5. Include parts numbers of all replaceable items.
6. Provide control diagram and operation sequence, along with labeling of control piping and instruments to match diagram.
7. Include a valve chart indicating valve locations.

E. Include air balance and/or water balance reports.

1.4 SUBMITTALS FOR COMMON HVAC REQUIREMENTS

A. Samples: Sealer and gauze proposed for sealing ductwork.

B. Quality Assurance / Control:
   1. Manufacturer's installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.
   2. Specification data on sealer and gauze proposed for sealing ductwork.

C. Quality Assurance
   1. Requirements: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.
   2. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.

1.5 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Perform work in accordance with applicable provisions of local and state Plumbing Code, Gas Ordinances, and adoptions thereof. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
   2. In case of differences between building codes, state laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Architect in writing of such differences.

B. Applicable Specifications: Referenced specifications, standards, and publications shall be of the issues in effect on date of Advertisement for Bid.
   1. "Heating, Ventilating and Air Conditioning Guide" published by the American Society of Heating and Air Conditioning Engineers.
   2. "Engineering Standards" published by the Heating, Piping, and Air Conditioning Contractors National Association.
   3. "2015 International Building Code", "2015 International Mechanical Code", "2015 International Plumbing Code" and "2015 International Fire Code" as published by the International Conference of Building Officials.
   4. "National Electrical Code" as published by the National Fire Protection Association.
   5. "2015 International Energy Conservation Code ".

C. Identification: Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when Project is turned over to Owner.

1.6 INSPECTIONS AND PERMITS

A. Pay for permits, fees, or charges for inspection or other services. Local and state codes and ordinances must be properly executed without expense to Owner and are considered as minimum requirements. Local and state codes and ordinances do not relieve the Contractor from work shown that exceeds minimum requirements.

1.7 ADDITIONAL WORK:

A. Design is based on equipment as described in the drawing equipment schedule. Any change in foundation bases, electrical wiring, conduit connections, piping, controls and openings required by alternate equipment submitted and approved shall be paid for by this division. All work shall be in accordance with the requirements of the applicable sections.

PART 2 - PRODUCTS FOR COMMON HVAC REQUIREMENTS

A. Finishes, Where Applicable: Colors as selected by Architect.

B. Duct Hangers:
   1. One inch 25 mm by 18 ga 1.27 mm galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 96 inches 2 400 mm apart. Do not use wire hangers.
   2. Attaching screws at trusses shall be 2 inch 50 mm No. 10 round head wood screws. Nails not allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Inspection:
   1. Examine premises and understand the conditions which may affect performance of work of this Division before submitting proposals for this work.
   2. No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.

B. Drawings:
   1. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc, and do not attempt to show complete details of building construction which affect installation. This Contractor shall refer to architectural, structural, and electrical drawings for additional building detail which affect installation of his work.
      a. Follow mechanical drawings as closely as actual building construction and work of other trades will permit.
      b. No extra payments will be allowed where piping and/or ductwork must be offset to avoid other work or where minor changes are necessary to facilitate installation.
      c. Everything shown on the mechanical drawings shall be the responsibility of Mechanical Contractor unless specifically noted otherwise.
   2. Consider architectural and structural drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over mechanical drawings.
   3. Because of small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions. Do not scale drawings for locations of equipment or piping. Refer to large scale dimensioned drawings for exact locations.

C. Insure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents.
   1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.

2. If non-specified equipment is used and it will not fit job site conditions, this Contractor assumes responsibility for replacement with items named in Contract Documents.

3.2 PREPARATION

A. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
   1. Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
   2. Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
   3. Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

3.3 INSTALLATION

A. Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.

3.4 STORAGE AND PROTECTION OF MATERIALS:

A. Provide storage space for storage of materials and assume complete responsibility for losses due to any cause whatsoever. Storage shall not interfere with traffic conditions in any public thoroughfare.

B. Protect completed work, work underway, and materials against loss or damage.

C. Close pipe openings with caps or plugs during installation. Cover fixtures and equipment and protect against dirt, or injury caused by water, chemical, or mechanical accident.

3.5 EXCAVATION AND BACKFILL

A. Perform necessary excavation of whatever substance encountered for proper laying of all pipes and underground ducts.
   1. Excavated materials not required for fill shall be removed from site as directed by Engineer.
   2. Excavation shall be carried low enough to allow a minimum coverage over underground piping of 5'-0" or to be below local frost level.
   3. Excess excavation below required level shall be backfilled at Contractor's expense with earth, sand, or gravel as directed by Engineer. Tamp ground thoroughly.
   4. Ground adjacent to all excavations shall be graded to prevent water running into excavated areas.

B. Backfill pipe trenches and allow for settlement.
   1. Backfill shall be mechanically compacted to same density as surrounding undisturbed earth.

2. Cinders shall not be used in backfilling where steel or iron pipe is used.
3. No backfilling shall be done until installation has been approved by the Engineer.

3.6 COOPERATION

A. Cooperate with other crafts in coordination of work. Promptly respond when notified that construction is ready for installation of work under Division 23000. Contractor will be held responsible for any delays which might be caused by his negligence or failure to cooperate with the other Contractors or crafts.

3.7 SUPERVISION

A. Provide a competent superintendent in charge of the work at all times. Anyone found incompetent shall be removed at once and replaced by someone satisfactory, when requested by the Architect.

3.8 INSTALLATION CHECK:

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

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

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

3.9 CLEANING EQUIPMENT AND PREMISES

A. Properly lubricate equipment before Owner's acceptance.

B. Clean exposed piping, ductwork, equipment, and fixtures. Repair damaged finishes and leave everything in working order.

C. Remove stickers from fixtures and adjust flush valves.

D. At date of Substantial Completion, air filters shall be new, clean, and approved by Owner's representative.

E. Trap elements shall be removed during cleaning and flushing period. Replace trap elements and adjust after cleaning and flushing period.

3.10 TESTS

A. No piping work, fixtures, or equipment shall be concealed or covered until they have been inspected and approved by the inspector. Notify inspector when the work is ready for inspection.

B. All work shall be completely installed, tested as required by Contract Documents and the city and county ordinances and shall be leak-tight before the inspection is requested.

C. Tests shall be repeated to the satisfaction of those making the inspections.

D. Water piping shall be flushed out, tested at 100 psi and left under pressure of supply main or a minimum of 40 psi for the balance of the construction period.

3.11 WARRANTEE

A. Contractor shall guarantee work under Division 23 to be free from inherent defects for a period of one year from acceptance.
   1. Contractor shall repair, revise or replace any and all such leaks, failure or inoperativeness due to defective work, materials, or parts free of charge for a period of one year from final acceptance, provided such defect is not due to carelessness in operation or maintenance.
   2. In addition, the Contractor shall furnish all refrigeration emergency repairs, emergency service and all refrigerant required due to defective workmanship, materials, or parts for a period of one year from final acceptance at no cost to the Owner, provided such repairs, service and refrigerant are not caused by lack of proper operation and maintenance.

B. In addition to warrantee specified in General Conditions, heating, cooling, and plumbing systems are to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.

3.12 SYSTEM START-UP, OWNER'S INSTRUCTIONS

A. Off-Season Start-up
   1. If Substantial Completion inspection occurs during heating season, schedule spring start-up of cooling systems. If inspection occurs during cooling season, schedule autumn start-up for heating systems.
   2. Notify Owner 7 days minimum before scheduled start-up.
   3. Time will be allowed to completely service, test, check, and off-season start systems. During allowed time, train Owner's representatives in operation and maintenance of system.
   4. At end of off-season start-up, furnish Owner with letter confirming that above work has been satisfactorily completed.

B. Owner's Instructions
   1. Instruct building maintenance personnel and Owner Representative in operation and maintenance of mechanical systems utilizing Operation & Maintenance Manual when so doing.
   2. Minimum instruction periods shall be as follows –
      a. Mechanical - Four hours.
      b. Temperature Control - Four hours.

c. Refrigeration - Two hours.

3. Instruction periods shall occur after Substantial Completion inspection when systems are properly working and before final payment is made.
4. None of these instructional periods shall overlap another.

3.13 PROTECTION

A. Do not run heat pump, air handling units, fan coil units, or other pieces of equipment used for moving supply air without proper air filters installed properly in system.

B. The mechanical systems are not designed to be used for temporary construction heat. If any equipment is to be started prior to testing and substantial completion, such equipment will be returned to new condition with full one year warranties, from date of substantial completion after any construction use. This includes, but is not necessarily limited to: Equipment, filters, ductwork, fixtures, etc.

3.14 COMMON HVAC REQUIREMENTS:

A. INSTALLATION
1. During installation, protect open ends of ducts by covering with plastic sheet tied in place to prevent entrance of debris and dirt.
2. Make necessary allowances and provisions in installation of sheet metal ducts for structural conditions of building. Revisions in layout and configuration may be allowed, with prior written approval of Architect. Maintain required airflows in suggesting revisions.
3. Hangers And Supports:
   a. Install pair of hangers close to each transverse joint and elsewhere as required by spacing indicated in table on Drawings.
   b. Install upper ends of hanger securely to floor or roof construction above by method shown on Drawings.
   c. Attach strap hangers to ducts with cadmium-plated screws. Use of pop rivets or other means will not be accepted.
   d. Where hangers are secured to forms before concrete slabs are poured, cut off flush all nails, strap ends, and other projections after forms are removed.
   e. Secure vertical ducts passing through floors by extending bracing angles to rest firmly on floors without loose blocking or shimming. Support vertical ducts, which do not pass through floors, by using bands bolted to walls, columns, etc. Size, spacing, and method of attachment to vertical ducts shall be same as specified for hanger bands on horizontal ducts.

B. CLEANING
1. Clean interior of duct systems before final completion.

END OF SECTION 23 0501

SECTION 23 0502 - DEMOLITION AND REPAIR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Under this section remove obsolete piping and mechanical equipment and relocate, reconnect or replace existing piping affected by demolition or new construction. Remove concealed piping abandoned due to demolition or new construction, or cap piping flush with existing surfaces.

1.3 DRAWINGS AND EXISTING CONDITIONS

A. All relocations, reconnections and removals are not necessarily indicated on the drawings. As such, the Contractor shall make adequate allowance in his proposal for this work as no extra charges will be allowed for these items.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 TEMPORARY CONNECTIONS

A. Where existing piping must remain in service to supply occupied areas during construction, provide temporary piping, connections, and equipment to maintain service to such areas. All shall be performed in a neat and safe manner to prevent injury to the building or its occupants.

3.2 EXISTING TO BE ABANDONED

A. All required drilling, cutting, block-outs and demolition work required for the removal and/or installation of the mechanical system is the responsibility of this Contractor.

B. No joists, beams, girders, trusses or columns shall be cut by any Contractor without written permission from the Architect.

C. The patching, repair, and finishing to existing or new surfaces is the responsibility of this Contractor, unless specifically called for under sections of specifications covering these materials.

D. Disconnect all equipment that is to be removed or relocated. Relocate any existing equipment that obstructs new construction.

3.3 EXISTING TO REMAIN IN USE

A. Where affected by demolition or new construction, relocate, replace, extend, or repair piping and equipment to allow continued use of same. Use methods and materials as

specified for new construction.

3.4 MATERIALS AND EQUIPMENT REMOVED

A. All obsolete materials, piping, and equipment shall become the property of the Contractor and be removed from the site promptly.

END OF SECTION 23 0502

SECTION 23 0514 – VARIABLE FREQUENCY DRIVE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install variable frequency drive system (VFD) as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. The complete VFD package being supplied shall be listed and carry the label of at least one of the following: UL - Underwriters Laboratory; ETL - ETL Testing Laboratories, Inc.; CSA - Canadian Standards Association.

1.4 SUPPLIER & VENDOR REQUIREMENTS

A. Suppliers of VFD systems must be in the primary business of supplying variable frequency drives and have a minimum of five (5) years of service in that business.

B. Vendor must have local service center with factory spare parts inventory and factory authorized service technician on call 24 hr/day. The vendor must be able to show that the recommended spare parts are available locally and any repair could take place within 24 hours for equipment supplied on this project.

1.5 TESTING

A. Prior to shipping, each unit shall be tested and a certified test report shall be supplied with each unit. Standard tests to include:
   1. Visual inspection - consisting of checking unit enclosure, wiring, connections, fasteners, covers and locking mechanism.
   2. High pot test: Two (2) X rated voltage plus 1000 volts AC for 60 seconds shall be applied per UL 508 on all peripheral drive system power components (circuit breakers, contactors, motor overloads, line reactors, disconnect switches, etc.) as a complete package. A copy of test results shall be included in operation manuals.
   3. Motor run test.
   4. Control panel devices; test all devices and lights.
   5. Optional equipment; test optional equipment specified with VFD system.
   6. Special tests; as required and specified.

1.6 DRAWINGS/MANUALS

A. Vendor shall supply approval drawings of system being supplied, in strict compliance with the specifications, within two (2) weeks ARO. Drawings shall include, as a minimum:

1. General arrangement of each unit showing size and incoming and outgoing conduit locations.
2. Schematic.
3. Connection diagram, sufficient to install drive system.

B. Each unit shall be supplied with two owner/maintenance manuals which shall include:
1. Vendor information of equipment being supplied.
2. Connection Information.
3. Startup Procedure.
4. Fault Reset Instruction.
5. Wiring Diagrams (power and control).
6. Parts List.
7. Test Results:
Harmonic voltage distortion on line with unit off
Harmonic voltage distortion with unit on line
Telephone Influence Factor (TIF) Report
Transformer Derate Report
Displacement Power Factor Report

1.7 WARRANTY

A. The vendor shall supply a warranty consisting of the following:
1. Unit shall carry a warranty of parts and labor for 1 year after start-up.
2. The unit is to be stored in a vendor approved area, said area to be free of dirt, vibration and moisture. Unit shall not be exposed to excessive heat or cold.
3. The unit is not to be started by owner or his contractor, but by a vendor-furnished field start-up service technician.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. The vendor shall verify compatibility of the VFD System being supplied with the specified motor. The motor shall be high efficiency with a 1.15 service factor, and shall be subject to VFD vendor approval.

B. Each system shall be supplied in a NEMA 1 force ventilated filtered enclosure, either wall mounted or free standing.

C. Each system shall have screened or engraved labels on all door operator and pilot devices.

D. Each system shall bear an electrical shock warning label to warn personnel that a potential of electric shock exists.

E. Each system shall be supplied complete, wired with all components assembled in a single enclosure including, but not limited to the VFD units, contactors, door interlocked circuit breaker, differential pressure controller, and/or other items listed in this specification or shown on the plans. Units requiring mounting and interwiring of separate bypass enclosure shall not be acceptable under this specification.

F. The vendor shall supply a complete set of engineering drawings consisting of, as a minimum, general arrangements, power wiring diagram, control wiring diagram and

schematic of VFD System components and options.

G. The vendor shall supply an owner's manual consisting of catalog sheets listing actual component and part numbers. Manual shall also show test certificates, warranty and service personnel responsible for warranty.

H. Vendor shall supply VFD System and start-up service. Mounting unit and connecting to power supply and mounting and wiring of remote devices shall be by mechanical contractor.

I. The VFD inverter shall be altitude compensated and sized for the elevation at which the unit will be installed. The inverter shall operate in an ambient temperature of -10 degrees C to 50 degrees C and humidity of 0% to 90% noncondensing.

J. The VFD inverter unit shall be mounted on a removable panel along with all other components such that, if required, panel could be removed from enclosure for maintenance or part replacement.

K. The door shall be mounted with a minimum of two hinges with removable pins. Door shall be rigid and large doors shall have additional hinges and stiffening steel.

L. Enclosure shall be painted with high grade enamel, with a minimum of 50-70 microns thick.

M. The enclosure shall be force ventilated and the exhaust ports covered with louvers. All components of the system shall be contained in this single enclosure as an integrated package.

N. Door mounted operator devices shall be industrial oil tight similar to those found on motor control centers.

O. All control power for operator devices and customer connections shall be 120 volts. The control power transformer shall be a "Machine Tool" type and have both primary and secondary fusing.

2.2 STANDARD FEATURES

A. The VFD unit shall be a solid state AC to DC converter sinusoidal pulse-width modulation (PWM) type.

B. The unit shall operate on:

Input Voltage ___480/60/3_ VAC +/- 10%
Input Frequency 60 Hz +/- 5%

C. Motor braking torque shall be available by means of regenerative braking.

D. The drive shall contain an output frequency clamp such that minimum of maximum output frequency can be set at desired limits.

E. Rated overload current shall be 110% for 1 minute.

F. The VFD unit shall have an adjustable acceleration/deceleration time setting from 1

second to 120 seconds.

G. The VFD unit shall maintain a 95% or better displacement power factor over the entire speed range.

H. The inverter shall be supplied with a door interlocked input disconnect motor circuit protector. The MCP shall allow trip adjustment sufficient to start the motor across the line in the bypass mode and normally be set at a minimum setting for maximum protection in the VFD mode. The door mounted handle shall be able to lock in the Off position.

I. The following door mounted operator controls shall be provided as a minimum:

Hand/Off/Auto Switch
Local/Remote Selector
Frequency Setting Speed Selector
Frequency Indication Meter Calibrated in % Speed
Power on Light
VFD/Bypass Switch
VFD Enable Light Bypass on Light
VFD Fault Light
External Fault Light (safeties interlock)

J. The inverter shall have a minimum of the following protective features with an alarm display indication:

Overcurrent shut-off
Regenerative Overvoltage
Electronic Thermal Protector
Heatsink Overheat
Instantaneous Power Failure
Ground Fault

K. The following termination points shall be provided on a terminal strip for field connections:

Safeties Interlock (N.C. Contacts by owner)
Remote Start/Stop Contact (N.O. Contacts by owner)
Remote VFD Fault Contact (N.C.)
Remote VFD/Bypass Enable Contact (N.O.)
Remote Electronic Signal Input (4-20Ma)

L. Auto restart shall be initiated by means of an automatic time delayed restart after recovering from undervoltage or loss of power. The inverter shall not automatically restart after overcurrent, overvoltage, overtemperature, or any other damaging conditions, but shall require a manual restart.

M. Bypass: The inverter shall be supplied with a bypass contactor arrangement for transfer to the feeder line to operate at constant speed. The Contactors shall be electrically and mechanically interlocked and supplied with an adjustable motor overload relay.

N. A VFD isolation switch shall be provided to allow maintenance on the VFD while

operating in the bypass mode. It will be prewired in the same enclosure, including contactors, input disconnect MCP, motor overload, VFD/Bypass selector switch and Bypass ON light.

O. Digital or Analog Ammeter.

P. Elapsed Time meter.

Q. NEMA 12 Enclosure with filters on forced-ventilation system.

R. Frequency Jump: The drive shall be supplied with the capability of being field retrofitted with a frequency jump control to avoid operating at a point of resonance with the natural frequency of the machine.

S. VFD unit shall have computer signal control option through the addition of a RS 232 data card which can be added at any time by plugging said card in existing unit.

T. Fault Diagnostics: The drive system shall have non-volatile fault retention so that the VFDs fault history is available from memory even after power loss.

2.3 APPROVED MANUFACTURERS

A. Energy Management Corporation EMC M Series

B. Mitsubishi VTP Series

C. Toshiba G2 Series

D. ABB

2.4 APPROVED SUPPLIERS

A. The following suppliers have been approved for assembling and local support of the VFDS:
1. Energy Management Corporation
2. Toshiba
3. Midgley-Huber
4. Other manufacturers and suppliers may submit for prior approval by submitting a point-by-point compliance to these specifications to the engineer at least 10 days before the published bid date. Sample test reports shall be included.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Painting: Manufacturer's standard paint shall be supplied. Touch-up paint shall be supplied if required.

B. Mounting and power connection shall be provided by mechanical contractor.

C. Vendor to supply field start-up service by an authorized factory service representative consisting of system check-out, start-up and system run. The vendor shall provide warranty and authorized factory service including operator training (if required). A

written certificate of same shall be provided at start-up. VFD service technicians shall be full time employees of the vendor or manufacturer, primarily engaged in VFD service work during normal business hours and also on call 24 hours a day. Start-up by sales representative is not acceptable.

END OF SECTION 23 0514

SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install identification of equipment and piping as described in Contract Documents.

B. Mechanical Contractor shall touch-up equipment where factory paint has been damaged. Repaint entire item where more than 20 percent of the surface is involved.

C. Primary painting of walls, ceilings, ductwork, piping and plenums is covered in the general painting section of these Contract Documents.

PART 2 - PRODUCTS

2.1 PAINT

A. Benjamin Moore Impervo or equivalent by Paint Manufacturer approved in Section 09 900.

B. Use appropriate primer.

2.2 LABELS

A. Black Formica with white reveal on engraving.

2.3 CODED BANDS

A. Using colored bands and arrows to indicate supply and return, with colored reflective tape, color code all piping installed in this contract at not more than 20-foot intervals, at equipment, at walls, etc., in accordance with ANSI Standards.

B. Approved Manufacturers:
   1. Seton
   2. Craftmark

2.4 PIPE IDENTIFICATION

A. In addition to the colored bands, stencil with black paint in 1/2 inch high letters a symbol and directional arrow for all fluids handled or use Seaton coded and colored pipe markers and arrows to meet ANSI Standards.

2.5 EQUIPMENT IDENTIFICATION

A. Provide an engraved plastic plate for each piece of equipment stating the name of the

item, symbol number, area served, and capacity. Label all control components with plastic embossed mechanically attached labels. Sample:

1. Supply Fan SF-1 - North Classrooms
2. 10,000 CFM @ 2.5"

2.6 VALVE IDENTIFICATION

A. Make a list of and tag all valves installed in this work.
   1. Valve tags shall be of brass, not less than 1"x2" size, hung with brass chains.
   2. Tag shall indicate plumbing or heating service.

PART 3 - EXECUTION

3.1 APPLICATION

A. Engraved Plates:
   1. Identify thermostats and control panels in mechanical rooms, furnaces, boilers and hot water heating specialties, duct furnaces, air handling units, electric duct heaters, and condensing units with following data engraved and fastened to equipment with screws –
      a. Equipment mark noted on Drawings (i.e., SF-1)
      b. Area served (i.e., North Classrooms)
      c. Capacity (10,000 CFM @ 2.5)

B. Stenciling:
   1. Locate identifying legends and directional arrows at following points on each piping system –
      a. Adjacent to each item of equipment and special fitting.
      b. At point of entry and exit where piping goes through wall.
      c. On each riser and junction.
      d. Every 50 feet on long continuous lines.
   2. Chilled Water, & Valve Identification –
      a. Identify specific pipe contents by stenciling pipe with written legend and placing of arrows to indicate direction of flow.

C. Painting:
   1. Background Color - Provide by continuous painting of piping.

Symbol	Name	Color
CHW	Chilled Water	Blue

   2. Identification stenciling and flow arrows shall be following colors for proper contrast:

Arrows & ID Stenciling	Color Shade of Pipe
White	Red, Grays, & black
Black	Yellows, Oranges, Greens, & White

END OF SECTION 23 0553

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 23 0501 - Common HVAC Requirements and Basic Mechanical Materials and Methods Sections apply to work of this section.

1.2 SUMMARY SCOPE

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems.
      a. VAV Boxes.
   2. Hydronic Piping Systems.
      a. Primary - Secondary Systems
      b. Chiller
      c. Pumps

1.3 SUBMITTALS

A. Agency Data:
   1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below. The firm or individuals performing the work herein specified may not be the installing firm.

B. Engineer and Technicians Data:
   1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.

D. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.

E. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below.
   1. Draft Reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.

2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 4 complete sets of final reports.
3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
   a. General Information and Summary
   b. Air Systems
   c. Temperature Control System Verification.

F. Report Contents: Provide the following minimum information, forms, and data:
1. General information and Summary: Inside cover sheet to identify testing, adjusting, balancing agency, Contractor, Owner, Engineer, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentation used for the procedures along with the instrument calibration sheet.
2. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form. The report shall contain the following information, and all other data resulting from the testing, adjusting, and balancing work:
   a. All nameplate and specification data for all air handling equipment and motors.
   b. Actual metered running amperage for each phase of each motor on all pumps and air handling equipment.
   c. Actual metered voltage at air handling equipment (phase-to-phase for all phases).
   d. Fan RPM for each piece of air handling equipment.
   e. Total actual CFM being handled by each piece of air handling equipment.
   f. Actual CFM of systems by rooms.
3. Certify that all smoke and fire dampers operate properly and can be reset under actual system operating conditions.

G. Calibration Reports:
1. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.4 CERTIFICATION

A. Agency Qualifications:
1. Employ the services of a certified testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement, and establishment

of the fluid quantities of the mechanical systems as required to meet design specifications, recording and reporting the results, and operation of all systems to demonstrate satisfactory performance to the owner.

2. The testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one person certified by NEBB or AABC as a Test and Balance supervisor, and a registered professional mechanical engineer, licensed in the state where the work will be performed.

B. Codes and Standard:
   1. NEBB: “Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.”
   2. AABC: “National Standards for Total System Balance.”
   3. ASHRAE: ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.

1.5 PROJECT CONDITIONS

A. Systems Operation: Systems shall be fully operation and clean prior to beginning procedures.

1.6 SEQUENCING AND SCHEDULING

A. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems within +10% to -5% of contract requirements.

B. The report shall be approved by the Engineer. Test and balance shall be performed prior to substantial completion.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system, perform these steps.
   1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
   2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
   3. Compare design to installed equipment and field installations.
   4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
   5. Check filters for cleanliness and to determine if they are the type specified.
   6. Check dampers (both volume and fire) for correct and locked position. Check automatic operating and safety controls and devices to determine that they are properly connected, functioning, and at proper operating setpoint.
   7. Prepare report test sheets for both fans and outlets. Obtain manufacturer’s outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross-check with required fan volumes.

8. Determine best locations in main and branch ductwork for most accurate duct traverses.
9. Place outlet dampers in the full open position.
10. Prepare schematic diagrams of system “As-Built” ductwork and piping layouts to facilitate reporting.
11. Lubricate all motors and bearings.
12. Check fan belt tension.
13. Check fan rotation.

3.2 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.3 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the

tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.

B. Provide instruments meeting the specifications of the referenced standards.

C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.

D. Apply instrument as recommended by the manufacturer.

E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5%. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

G. Take all readings with the eye at the level of the indicated value to prevent parallax.

H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

I. Take measurements in the system where best suited to the task.

3.4 PERFORMING TESTING, ADJUSTING, AND BALANCING

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards. Balancing of the air systems and hydronic systems shall be achieved by adjusting the automatic controls, balancing valves, dampers, air terminal devices, and the fan/motor drives within each system.

B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

C. Patch insulation, ductwork, and housings, using materials identical to those removed.

D. Seal ducts and piping, and test for and repair leaks.

E. Seal insulation to re-establish integrity of the vapor barrier.

F. Adjust timing relays of environmental equipment motor reduced voltage starters to the optimum time period for the motor to come up to the maximum reduced voltage speed and then transition to the full voltage speed to prevent damage to motor, and to limit starting current spike to the lowest possible and practical.

G. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

H. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.5 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.

B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

C. Report shall be certified and stamped by a registered professional mechanical engineer employed by the agency and licensed in the state where the work will be performed.

D. Engineer is to provide a floor plan and test and balance contractor to include the plan in test and balance report and identify actual cfm on drawing or number the diffusers to match report.

3.6 DEMONSTRATION

A. If requested, testing, adjusting, and balancing agency shall conduct any or all of the field tests in the presence of the engineer.

B. Agency shall include a maximum of one (1) call back to the project within the one year warranty period to make additional adjustments if requested by the engineer.

END OF SECTION 23 0593

SECTION 23 0712 - MECHANICAL INSULATION AND FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install mechanical insulation and fire stopping as described in Contract Documents including but not limited to the following:
   1. Chilled Water Cooling
   2. Ductwork Insulation
   3. Fire Stopping

1.3 QUALITY ASSURANCE

A. Insulation shall have composite (insulation, jacket or facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard ratings as tested by Procedure ASTM E-84, NFPA 255 and UL 723 not exceeding: Flame Spread of 25 and Smoke Developed of 50.

B. Insulation Contractor shall certify in writing, prior to installation, that all products to be used will meet the above criteria.

C. Accessories, such as adhesives, mastics, cements, and tapes, for fittings shall have the same component ratings as listed above.

D. Products, or their shipping cartons, shall bear a label indicating that flame and smoke ratings do not exceed above requirements.

E. Any treatment of jacket or facings to impart flame and smoke safety shall be permanent.

F. The use of water-soluble treatments is prohibited.

END OF SECTION 23 0712

SECTION 23 0714 – PREMOLDED ONE PIECE PVC FITTINGS INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install premolded one piece PVC fittings insulation as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Fittings shall be UL rated 25/50 PVC.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Approved Manufacturers:
   1. Zeston

PART 3 - EXECUTION

3.1 INSTALLATION

A. Where factory premolded one piece PVC insulating fitting covers are to be used, proper factory precut Hi-Lo Temp insula tion shall be applied to the fitting. Ends of Hi-Lo Temp insulation shall be tucked snugly into throat of fitting and edges adjacent to pipe covering tufted and tucked in. Fully insulate pipe fittings. One piece PVC fitting cover is then secured by stapling, tack fastening, banding or taping ends to adjacent pipe covering.

B. Cold:
   1. Chilled water systems shall be insulated as "A" above and have all seam edges of cover sealed with Zeston's vapor barrier adhesive or equal.
   2. Circumferential edges of cover shall be wrapped with Zeston's vapor barrier pressure sensitive color matched Z tape.
   3. Tape shall extend over adjacent pipe insulation and have an overlap on itself at least 2" on downward side.

END OF SECTION 23 0714

SECTION 23 0715 – CHILLED WATER SUPPLY & RETURN PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install insulation on piping mains, branches, risers, fittings, and valves, pump bodies and flanges as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIAL

A. 3 lb./cu.ft. heavy density fiberglass with fire retardant vapor barrier jacket with self sealing laps. Thickness shall be 1-1/2 inches on heating supply and return lines.

B. Approved Manufacturers:
   1. Owens-Corning Fiberglass heavy density with ASJ-SSL jacket
   2. Equals by Johns-Manville or CTM.
   3. Zeston covers for valves and fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipes:
   1. Install in accordance with manufacturer's directions on clean dry pipes.
   2. Butt joints firmly together.
   3. Seal vapor barrier longitudinal seam overlap with vapor barrier adhesive.
   4. Wrap butt joints with four inch strip of vapor barrier jacket material cemented with vapor barrier adhesive.
   5. Finish with bands applied at mid-section and at each end of insulation.

B. Valves & Fittings:
   1. Insulate and finish by one of following methods:
      a. With hydraulic setting insulating cement, or equal, to thickness equal to adjoining pipe insulation.
      b. With segments of molded insulation securely wired in place.
      c. With prefabricated covers made from molded pipe insulation finished with vapor barrier adhesive.
      d. Zeston covers and factory applied insulation diapers.
   2. Finish fittings and valves with four ounce canvas and coat with vapor barrier adhesive or Zeston covers.

C. Piping located outdoors and exposed to the weather shall be insulated as indicated above except the thickness shall be determined according to the worst weather

extremes expected. The insulation shall then be protected with one of the following weatherproof finishes as indicated on contract drawings:

1. Metal jacketing shall be 0.016" (0.4 mm) minimum aluminum or stainless steel with moisture barrier, secured in accordance with the jacket manufacturer's recommendations. Joints shall be applied so they will shed water and shall be sealed completely.
2. UV resistant PVC jacketing may be applied in lieu of metal jacketing provided jacketing manufacturer's limitations with regard to pipe size, surface temperature, and thermal expansion and contraction are followed.
3. Fittings shall be insulated as prescribed above, jacketed with preformed fitting covers matching outer jacketing used on straight pipe sections, with all joints weather sealed.
4. On outdoor chilled water and refrigerant lines, the insulation system shall be completely vapor sealed before the weather-resistant jacket is applied. The outer jacket shall not compromise the vapor barrier by penetration of fasteners, etc. Vapor stops at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

END OF SECTION 23 0715

SECTION 23 0800 – FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install fire stopping as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Fire stopping material shall meet ASTM E814, E84 and be UL listed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Material shall be flexible, long lasting, intumescent acrylic seal to accommodate vibration and building movement.

B. Caulk simple penetrations with gaps of 1/4" or less with:
   1. Dow Corning Fire Stop Sealant
   2. Pensil 300

C. Caulk multiple penetrations and/or penetrations with gaps in excess of 1/4" with:
   1. Dow Corning Fire Stop Foam
   2. Pensil 200
   3. IPC flame safe FS-1900
   4. Tremco “Tremstop 1A”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer's installation instructions explicitly.

B. Seal penetrations of ductwork, piping, and other mechanical equipment through one-hour and two-hour rated partitions as shown on Architectural and Mechanical Drawings.

C. Install fire stopping material on clean surfaces to assure adherence.

END OF SECTION 23 0800

SECTION 23 0953 – TEMPERATURE CONTROLS (DDC)

PART 1 - SYSTEM OVERVIEW

1.1 DDC CONTROL SYSTEM

A. Statement of Intent: The intent of this specification is to provide a high-quality Direct Digital Control system at Madison Middle School for integration into the current Madison County School District WebCTRL™ front end. In order to maintain seamless interface and consistency of user screens all new control hardware must be programmed using the Eikon™ control programming utility. System must continue to have realtime presentation of these programs showing current operating parameters and conditions. Graphical User Interface screens must be developed using ViewBuilder™ graphics development software.

B. Specification Compliance: These specifications are intended to provide a minimum capability for the DDC system. Manufacturer's data sheets included in the submittals will be reviewed to verify significant hardware and software system features. Key system features must be documented by manufacturer's data sheets in the submittals or by demonstration of an existing installation. Anyone wishing approval to bid must coordinate with the Mechanical Engineer and School District personnel not later than 10 days prior to bid date for a system demonstration of integration capabilities to existing front end software as noted above.

C. Approved DDC Contractor and System
   1. DDC Control System shall be:
   2. Automated Logic WebCTRL by Clima-Tech Corporation

1.2 SCOPE OF WORK

A. Control Hardware and Software: Automatic Temperature Control Contractor shall be responsible to furnish and install all control hardware and software necessary for complete DDC control system as specified. ATC contractor shall furnish all modules, temperature sensors, flow sensors, humidity sensors, IAQ sensors, control valves, control valve actuators, dampers, damper actuators and any other items necessary for a complete system and sequence of control.

B. Specifically the ATC Contractor shall furnish the following:
   1. Individual unitary control modules for each unitary system:
      a. VAV Boxes
      b. Air Handling Units

C. Individual control modules for all non unitary air handlers or package units:
   1. Furnaces
   2. Unit Heaters

D. General purpose modules for control of central fan, pump, chiller, boiler or tower operation:
   1. Hot Water Systems
   2. Chilled Water Systems
   3. Hot Water Loop Circulation System

4. Chiller Control
5. Domestic Hot Water System

E. Control Wiring and Interface to Line Voltage Control
   1. ATC Contractor shall be responsible for all wiring required for this project regardless of VA requirements.

F. Commissioning: ATC Contractor shall be responsible for self-commissioning of all hardware and software furnished with the project. Completed field commissioning sheets shall be included with the final “as-built” O&M manuals. These sheets shall include validation check fields for all physical and LAN inputs and outputs and graphics for each operating unit or system within the facility. Each system and point shall be listed, using logical names for future reference by the owner. Commissioning shall include calibration and verification of operation of each I/O and graphic field. Functional commissioning of software programming to meet sequences of operation as submitted and approved shall be verified on the field commissioning sheets.

G. Training and Technical Support: Contractor shall provide 8 hours of training to owner representatives on operation and servicing of automatic temperature control system. Training shall be oriented to making the owner self sufficient in the day to day use and operation of the DDC system. Additionally the training shall include information specifically focused on showing the owners representative methods of troubleshooting the mechanical systems using the DDC system. For this purpose, the trainer must be well grounded in both DDC system operation and in mechanical systems service.

H. The contractor shall provide unlimited phone technical support to the owners representative during the one year warranty period. If the technical support location of the contractor is outside of the toll free calling area for the customer, the contractor shall have a toll free number or accept collect calls for the purpose of providing technical support.

1.3 SUBMITTALS AND O&M MANUALS

A. Submittals
   1. Submittals shall include the following sections:
   2. Shop Drawings with:
      a. Title Page
      b. Table of Contents
      c. Typical Device Wiring Drawings
      d. Summary Bill of Materials
      e. Local Area Network Drawings
      f. Drawings for all operating systems showing both equipment and module connections
         (Note: drawings for individual operating systems shall include individual Bills of Materials)

B. Sequences of Operation
   1. Manufacturers specification data sheets for all control modules, sensors, dampers, valves, actuators, flow switches, current sensors and transducers required in the project.

2. If the contractor wishes to substitute any item after approval of submittal they shall submit appropriate data sheets for approval before including substituted product on the project.

B. O&M Manuals
   1. O&M Manuals shall be furnished upon project completion and include technical instructions for all items originally included in the submittal with “as built” modifications and completed Commissioning Worksheets. O&M Manuals shall be in a separate three ring binder. Contractor’s toll free technical support number or the words “Call Collect” with the contractor’s regular phone number shall be on the front of the manual.

1.4 SYSTEM SOFTWARE

A. System Software
   1. All operating program and site specific software shall be furnished to the owner on 3½” diskettes or CD ROM disks.

PART 2 - CONTRACTOR CAPABILITY

2.1 Contractor shall maintain toll-free technical support phone line or accept collect phone calls during warranty period. Contractor shall provide service within 24 hours. Contractor service and installation technicians shall be technically proficient in both control systems and mechanical service.

PART 3 - PRODUCT CAPABILITY - HARDWARE

3.1 SYSTEM SERVER
A. Software shall be installed on owner’s existing WebCTRL server.

3.2 FIELD HARDWARE

A. BACnet Compatibility
   1. The system shall be fully native BACnet at the time of installation. The system shall use BACnet as the native communication protocol between distributed controllers communicating on the controller network (i.e. Field Bus) and must, as a minimum, support the following Objects and Application Services (Conformance Class 3):

B. Objects	Binary Input	Services>	Readproperty
	Binary Output		Writeproperty
	Binary Value		I-Am
	Analog Input		I-Have
	Analog Output		ReadMultiple Property
	Analog Value		WriteMultiple Property
	Calendar		Who-Has
	Schedules		Who-Is

C. Distributed Control: System shall observe the concept of distributed control. All modules shall have “stand alone” capability and shall maintain operator setpoints without connection to primary controllers or central station equipment. Modules shall be located

at each operating equipment location such that individual systems or zones shall remain functional without communication to other systems on the network. Equipment operating logic, schedules and current trends shall reside in control modules serving each system. Use of global modules required to maintain programming, schedules or current trend data are not acceptable.

D. Ethernet Gateway Routers: System shall include an Ethernet Router/Gateway between the control module network and owners Ethernet. This gateway shall route BACnet communications between the control module network and the owners IP network. If the system is not to be connected to customer Ethernet the gateway shall be capable of connection via a web browser on the local host server.

E. Control Modules: Control modules shall include required inputs and outputs to meet sequence of operation and points list. Digital outputs shall be dry contact relays and analog outputs shall be industry standard 0-10 vdc, 2-10 vdc or 4-20 milli-amp. Triac digital outputs are not acceptable. Modules shall be fully programmable for maximum system flexibility. Application specific controllers are not acceptable.

F. All modules shall have battery backup capable of maintaining all programs, setpoints, schedules and trend information for a minimum of 7 days.

F. All schedules and current trends shall be maintained in the individual control modules. The modules shall be capable of maintaining sufficient trend samples to report 24 hours of trend history in 5 minute increments for each input or output.

G. Temperature Sensors: Wall mounted zone temperature sensors shall be 10 k ohm thermistor. Zone sensors in primary occupied areas other than restrooms, hallways or storage rooms shall have setpoint adjustment to allow the occupants to raise or lower setpoint within operator defined paramenters. Additionally sensors in these primary areas shall have a push button to return the system to normal occupancy setpoints for an operator defined period. Exception will be common areas. Zone sensors for restrooms, hallways, storage rooms, gymnasiums, auditoriums and locker rooms shall be mounted on the back of an aluminum electrical box cover plate designed for zone sensing application. Gymnasium sensors shall also include a key access override feature.

H. All other temperature sensors shall be industry standard thermistor or 4-20 milli-amp. Immersion sensors shall be mounted in a blind well for future serviceability.

I. Valve and Damper Actuators: Actuators shall be manufactured by Belimo. Torque shall be rated for required load. Modulated actuator input shall be industry standard 0-10 vdc, 2-10 vdc, 4-20 milli-amp, floating motor (tri-state), or pulse width modulation. Two or three position operation is not acceptable for economizers, VAV dampers, multizone dampers, valves or any other application specifying modulated operation.

J. Dampers: Outside air control dampers shall have neoprene or vinyl-grip blade seals, stainless spring steel edge seals and a specified leakage rate of not more than 65 CFM/damper face area at 2” W.G. static pressure drop.

K. Wire: All wiring in open areas at heights below 12 feet must be run in conduit, otherwise control wiring may be run open in accessible ceiling or underfloor areas. Control wiring

in non-accessible ceilings, walls or floors shall be in conduit. All wiring not in conduit or control cabinets shall be rated for plenum installation. Communication wiring shall be run in data cable tray whenever possible.

PART 4 - PRODUCT CAPABILITY - SOFTWARE

A.. BACnet COMPATIBILITY

1. The system shall be fully native BACnet at the time of installation. This means that the system must use BACnet as the native communication protocol between distributed controllers communicating on the controller network (i.e. Field Bus) and must, as a minimum, support the following Objects and Application Services (Conformance Class 3):

2.

Objects >		Services >	
	Binary Input		Readproperty
	Binary Output		Writeproperty
	Binary Value		I-Am
	Analog Input		I-Have
	Analog Output		ReadMultiple Property
	Analog Value		WriteMultiple Property
	Calendar		Who-Has
	Schedules		Who-Is

B. Programming for the system shall use BACnet objects and services. All BACnet objects and services shall be opened for read and/or read/write access during programming for future exposure to other BACnet systems. The front end software for the system shall be able to query other third party BACnet points for read/write access.

C. MULTIPLE OPERATING PLATFORMS

1. The front end server software furnished as a part of the DDC system shall be capable of operating on multiple operating systems such as Microsoft Windows, Linux or Sun Solaris.

D. GRAPHICAL PROGRAMMING

1. The system shall be programmed using Eikon™ graphical programming language for ease of operator understanding. Operating sequences and logic flow shall be assembled in a schematic format using MicroBlocks representing inputs, outputs and logical functions such as setpoints, switches, limits, relays, PIDs etc. The programming software shall be furnished within this scope of work.

2. Full simulation capability shall also be provided with the graphic programming. User shall be able to fully simulate the constructed sequence on screen before the sequences are downloaded into the controllers. The system shall also include the ability to simulate multiple graphic programs communicating with each other on a simulated network.

E. GRAPHICAL INTERFACE SOFTWARE

1. System and Equipment Graphic User Interface: The operators interface software shall be developed using ViewBuilder™ graphical development software. Graphics display screens shall include a system level graphic of either a map of facilities or an elevation of the building, a graphic of each building floor plan and graphics for each operating system or unit within each building. Entry to the zone and equipment level interface graphics shall be through area maps and/or floor plans to facilitate user orientation. Additionally the system hierarchy shall be displayed in a fashion similar to Windows Explorer to enable the user to navigate to any graphical screen in the system by expanding building levels or floor levels and selecting a particular zone or system. Graphics shall be accessed by using a mouse or other pointer device. The system shall provide a visual indication of which building, floor and zone the user is accessing at any time. System shall be capable of changing all parameters and schedules, as well as downloading operating software from the same Graphical User Interface software program as that used for viewing system operation.

2. Thermal graphic floor plans shall display each temperature zone in a color appropriate to current space temperature conditions. The system shall display in 8 separate colors the following conditions: High or low temperature alarm, temperature at setpoint, cooling call, heating call, more than 2° above setpoint, more than 2° below setpoint, unoccupied between setpoints and no communication. Floor plans shall also include color graphic indicators for non-zone specific mechanical equipment operation showing On/Off and Alarm Conditions. Status indication colors shall be updated dynamically as conditions change.

3. Mechanical equipment pictorial graphics shall be displayed by the use of point-and-shoot selection using a mouse or other pointer device. Graphics shall be provided for all mechanical equipment and devices controlled by the DDC system. These graphics shall provide a current status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate engineering units at appropriate locations on the graphic representation.

4. Software Graphic Programming Live User Interface: The system shall be able to display the graphic displays of system programming, operating logic and logic flow with real time conditions displayed at each input, output and logical function. This display will allow the operator to observe each step of a control logic process and facilitate system software troubleshooting. Operator shall have the ability to select any MircoBlock in the graphical program to change parameters including the ability to lock values.

F. FACILITY MANAGEMENT AND ENERGY MANAGEMENT FUNCTIONS

1. Scheduling: The DDC system shall have the ability to schedule each individual zone, each building or floor or the entire network of buildings for any user with a single entry. Additionally the operator shall have the capability of assembling groups of zones, buildings or floors for single entry programming, e.g. several offices may be grouped for scheduling of Saturday operations. Available schedule types shall include normal operation, unoccupied operation, setback override and holidays. For maximum flexibility, schedules shall reside in the local control modules. Dated schedules shall be self managing and automatically delete after execution.

2. Interactive Operations: The system shall have the ability to send run requests, heating requests and cooling requests from one module to another for the purpose of optimizing run operations of central plant equipment. Additionally the system shall be capable of limiting operation of various equipment if another mechanical point elsewhere in the system allows that operation. e.g. a boiler loop circulating pump shall run only when requested by a zone requiring heating operation and will shut down during hours that zone demand is satisfied.

G. ALARMS, TRENDS AND REPORTS

1. System and Temperature Alarms: The system shall have the capability of monitoring conditions throughout the system and sending alarms or messages to an e-mail address, local PC or printer or to remote PC's, printers or to dial-up pagers. Alarms and messages shall be able to be prioritized for various levels of reporting and action. The operator shall have the ability to customize alarm text and messages.

2. Trends: The system shall be capable of trending any input or output, or any logical point within the graphic program. There shall be no limitation to the number of points that can be trended at any particular time. Modules shall store in live memory 288 trend samples points for each trended item. The interval between trend samples shall be adjustable from 1 second to 24 hours. Trends from one or more modules shall be able to be simultaneously displayed on a single trend graph. Operator shall be able to "window" any segment of a trend to enlarge the view by dragging a mouse to form the "window". The system shall also have the ability of automatically downloading trend information from any module to the server or other computer connected to the network for historical trend storage. This trend information shall be able to be displayed on the trend graph along with live current trends in seamless fashion. Trend data collection requiring the use of a locally connected PC for data storage is unacceptable.

3. Reports: The system shall be capable of generating reports of equipment run times, all trended points, temperature conditions, electric demand and usage and alarms or messages. The system shall also have the ability of automatically downloading report information from any module to the server or other computer connected to the network. The operator shall have the ability to create custom report and logging formats.

PART 5 - SEQUENCES OF OPERATION

1.1**.** General Sequences – Applies to All Systems

A. Adjustable Parameters

B. All numeric values in the Sequence of Operation are adjustable parameters that can be modified without program changes or re-downloading that would interrupt system operation.

1.2 Power Loss to Control Modules

A. All control modules are equipped with battery backup and will retain programming, including time of day, upon loss of power. On return of power, control functions will return to normal operation based on scheduling and time of day with no operator

intervention. Delay on start parameters can be setup at random intervals to prevent demand surges on restart.

1.3 Power Loss to Server

A. On loss of power to the server only the BAS will continue to run as normal. The BAS human interface software, WebCTRL, is a network service and will automatically restart and connect to the system when power is restored.

1.4 Trends

A. Trending is available, by default, on any BACnet I/O point. Trends can also be added for any digital or analog value as well as any logical value in the graphical program, e.g. a PID output could be trended.

B. Trending will be setup for all significant I/O points. Analog values will be set to log every 5 minutes and store 288 data points for live retrieval. Binary points will be set to trend on Change of Value (COV) and to store 100 COV trend samples live. Sample frequency and quantity of stored data are adjustable within the memory limits of each module. e.g. Trends can set to be logged every 5 minutes with 288 trend points allocated so that the live display will show 24 hours of trend data.

C. Trends are stored in module memory. Extended trending is available by archiving trends using Trend Historian for server storage.

1.5 Schedules

A. Occupancy schedules will initiate from the zone level. Air handling units, chillers, boilers, pumps etc. whose operation is intended to provide air or water flow to zones will function based on Run Requests, Cooling Requests or Heating Requests from the zones they serve. These central systems will not have separate scheduling capability.

B. Schedules can be set for all systems in a customer database, or for a single building, a single floor, or for an individual zone. Additionally, groups of equipment can be assembled in Schedule Groups for single entry scheduling of multiple zones for specific functions. For Example:
   1) A Gym Activities Group could be used for single entry scheduling for practices, ball games etc.
   2) Another example would be a group of rooms occupied by a single tenant who has frequent need for space conditioning during otherwise unoccupied times.

C. Schedules can be set for weekly reoccurring occupancy, dated weekly, date, date range, wildcard or continuous and can be set for multiple years in advance.

D. Timed Local Override (TLO), if available from the local sensor, will override unoccupied schedule, placing equipment in occupied operation for the programmed time period. TLO can be programmed for fixed duration, e.g. 180 minutes, or for time durations that accumulate with each push or pulse of the override button, e.g. 30 minutes per pulse with 180 minutes maximum override. The second option is the default standard.

1.6 Unoccupied Operation

A. Whenever system operation is required to maintain low or high temperature limits during unoccupied hours of operation, PID control of heating and cooling functions will be bypassed and systems will go to 100% operation until setpoint is satisfied.

B. Capability will be in the software to set an On/Off differential greater than occupied differential to reduce the frequency of unoccupied cycling, e.g. heating might be set to cycle on at 55°F and remain on until 58°F is reached.

1.7 Optimal Start

A. Zone start time will be adjusted based on indoor and outdoor temperatures so as to achieve occupied temperatures at the scheduled occupancy time. Optimal start can be adjusted by changing the capacitance values of each zone in the program. A learning adaptive feature can be enabled allowing the zone control to automatically adjust the capacitance to optimize start times. Both optimal start and learning can be disabled.

1.8 Load to Source Control

A. Central air handling equipment serving multiple zones will operate based on Run Requests from connected zones.

B. Central systems such as boilers, chillers and pumps will operate based on Heating, Cooling or Run Requests from connected air handlers or zones as required.

1.9 Outside Air Conditions

A. Outside air temperature will be monitored and averaged over a ten minute period. Alternate outside air temperature is available by default in programming and can be mapped to another site for backup or can be left unused.

B. Outside air conditions can be mapped to any controller for use for local control sequencing.

1.10 Night Purge (Flush) Operation

A. System will be installed with programming for Night Purge operation designed to use low temperature night time air to pre-cool the facility during warm weather periods. Night Purge programming consists of a Global Broadcast to initiate three levels of purge at the zone level. Each zone will be programmed to receive Night Purge level broadcasts and initiate logic as described in the General Zone Sequences section below.

B. The DDC system will receive daily weather forecasts from the National Weather Service to provide Purge logic. Whenever the high temperature for the next day is forecast to be above 70° a global program will broadcast Purge Levels to all zone modules. When the forecast high is greater than 80°F Purge Level III will be broadcast to each zone. If the forecast is between 75°F and 80°F a Level II broadcast will be sent. If the forecast is between 70°Fand 75°F a Level I broadcast will be sent.

C. Night purge can be deactivated through DDC by time of year (month and day) or manually through DDC.

1.11 Alarming

A. All alarms generated by WebCTRL may be setup for the following actions:

1) Alarm Popup
2) Print
3) Propagate To Server
4) Run External Program
5) Send Alphanumeric Page
6) Send E-Mail
7) Write to File
8) Send SNMP Trap*
9) Write Property*
10)...Write to Database*

*Applies only if system has the Advanced Alarming Package

B. All alarms may be enabled or disabled by the operator without program change or memory download.

C. All alarms are set with default messages. Custom messages may be setup without program change or memory download.

D. Not all available alarms are enabled except when requested or when it appears appropriate.

2. Job Specific Sequences

2.1 VAV Box w/HW Reheat

A. This sequence applies to all VAV terminal units.

B. Run Conditions
1) Zone shall have independent schedule capability. Scheduling shall be from a global schedule input, from local schedule or from a group schedule.
2) Outside air temperature shall be available from a global broadcast for local control options.

C. Zone Temperature Setpoint Control
1) Zone sensor shall include setpoint adjustment, timed local override, and display (except restroom zones, halls, and other areas where local user adjustment would not be preferred).
a) Default setpoint adjustment will be ±1°F and timed override will be 30 minutes per user button press with a maximum override of 180 minutes. Adjustment values and override times shall be programmable for each sensor.
2) Zone setpoint control uses a modified Zone PID algorithm to provide a smooth, modulated variable for cooling and heating.
3) Default Setpoint Values (adjustable per zone):
a) When Scheduled Occupied:
i) Occupied Cooling Setpoint = 74°F.
ii) Occupied Heating Setpoint = 70°F
b) When Scheduled Unoccupied:
i) Unoccupied Cooling Setpoint = 85°F.
ii) Unoccupied Heating Setpoint = 55°F.

D. Night Purge Mode
1) Night Purge setpoints will be set by purge level from Global Night Purge Broadcast.
a) Level 1 Night Purge cooling setpoint will be 69°F.

b) Level 2 Night Purge cooling setpoint will be 67°F.
c) Level 3 Night Purge cooling setpoint will be 65°F.

2) During Night Purge Mode Zone dampers will modulate to 100% Cooling CFM position until zone falls below cooling setpoint.
3) Night Purge heating setpoint will be offset down by 5°F until scheduled occupancy. On initiation of occupancy heating setpoint will be reset up 1°F every 30 minutes until occupied heating setpoint is reached. This is to prevent reheating a zone that has just night purged.
4) Night purge will begin when:
   a) A Night Purge Mode broadcast is received.
   b) It is 5 hours prior to scheduled occupancy.
   c) Zone temperature is 1°F above night purge setpoint.
   d) OA temperature is above 45°F and more than 10°F below zone temperature.
5) Night Purge Mode will end one hour prior to occupancy.

E. Cooling Control
   a) When space temperature rises above cooling setpoint the zone setpoint control PID will modulate the variable air volume damper between the minimum ventilation air flow setpoint to maximum cooling air flow to maintain space cooling setpoint.
   b) If the space is requesting cooling and AHU supply air temperature exceeds zone temperature the VAV damper will modulate to minimum CFM Setpoint.

F. Heating Control with Modulating Hot Water Valve
   a) When space temperature falls below heating setpoint the zone setpoint control PID will modulate the output to the HW valve between 0 and 100% as zone heating PID varies between 0 and 100%.
   b) A second PID will increase Zone CFM setpoint from Minimum to 75% of maximum CFM setpoint to maintain a maximum supply air temperature of 90°F to minimize stratification and promote better heating distribution.
   c) Heating will be locked out when outside air temperature is above 65°F.

G. Unoccupied Heating
   a) When any one zone requests unoccupied heating, all zones associated with that AHU will activate unoccupied heating and all zones will heat to 5°F above their unoccupied heating setpoint before the AHU is no longer requested to run for unoccupied heating.

H. Communication between parent AHU and child Zone
   a) The following network points will be read by parent AHU and sent by child Zone. These are the normal standard but any value can be mapped to the parent AHU from the child Zone.
      i) Occupied Run time
      ii) Unoccupied Run time
      iii) Zone Cooling Percent
      iv) Zone Heating Percent
      v) Zone Damper Position
      vi) Night Flush request
   b) The following network points will be read by child Zone and sent by parent AHU. These are the normal standard but any value can be mapped to the child Zone from the parent AHU.

i) AHU Supply Air Temperature
ii) AHU Supply Static Pressure

I. Safeties and Alarms
1) Zone Temperature Alarm
a) Zone control shall alarm on high or low zone temperature.
b) Zone Temperature alarms will be disabled during Optimal Start, first 30 minutes of scheduled occupancy or during Setback override.
2) Supply Air Temperature Alarm
a) Supply air temperature monitor shall be included and shall alarm on high or low supply air temperature differential from space temperature.

J. BAS Graphics will include the following
1) Outside air temperature
2) Zone temperature/user offsets
3) Heating and cooling setpoint/deadbands
4) Supply air temperature
5) Air volume
6) Air Volume Setpoint
7) Damper Position
8) Reheat valve position

2.2 HW Unit Heater

A. This sequence applies to all HW unit heaters.

B. Run Conditions
1) Zone shall have independent schedule capability. Scheduling shall be from a global schedule input, from local schedule or from a group schedule.
2) Outside air temperature shall be available from a global broadcast for local control options.

C. Zone Temperature Setpoint Control
1) Zone sensor shall include setpoint adjustment, timed local override, and display (except restroom zones, halls, and other areas where local user adjustment would not be preferred).
a) Default setpoint adjustment will be ±1°F and timed override will be 30 minutes per user button press with a maximum override of 180 minutes. Adjustment values and override times shall be programmable for each sensor.
2) Zone setpoint control uses a modified Zone PID algorithm to provide a staged variable for cooling and heating. The equipment will cycle on at preset PID output and off when PID output drops to a lower preset level from the PID.
3) Default Setpoint Values (adjustable per zone):
a) When Scheduled Occupied:
i) Occupied Heating Setpoint = 70°F
b) When Scheduled Unoccupied:
i) Unoccupied Heating Setpoint = 55°F.

D. Supply Fan Control
1) The supply fan will be enabled to run continuously whenever zone is operating in an occupied mode and will cycle on for heating to maintain unoccupied zone setpoints.
2) Fan status will be monitored. (See Safeties and Alarms below)

3) Heating will be disabled until fan status is proven.

E. Heating Control with 2-position Hot Water Valve
   1) On fall of zone temperature to heating setpoint, the HW valve shall be operated to maintain zone temperature based on the output of the Zone Heating PID.
      a) Hot Water Valve will be commanded open at 80% of PID (adj.)
      b) Hot Water Valve will be commanded closed at 5% of PID (adj.)
   2) Heating will be locked out when outside air temperature is above 65°F.

F. Safeties and Alarms
   1) Zone Temperature Alarm
      a) Zone control shall alarm on high or low zone temperature.
      b) Because these zones have no cooling capacity, if high zone temperature alarm is enabled it will typically be set to alarm at > 80°F (adjustable).
      c) Zone Temperature alarms will be disabled during Optimal Start, first 30 minutes of scheduled occupancy or during Setback override.
   2) Fan Motor Status Alarm
      a) BAS will monitor fan status via a current sensing switch (CT). If fan has been commanded to run by the BAS and the fan status is not indicated, BAS will generate an alarm.

G. BAS Graphics will include the following
   1) Outside air temperature
   2) Zone temperature/user offsets
   3) Heating and cooling setpoints/deadbands
   4) Unit status/start/stop
   5) Hot water valve position

2.3 Zone SF Control

A. This sequence applies to zone SF-1, 2, 3, & 4.

B. Run Conditions
   1) Zone shall have independent schedule capability. Scheduling shall be from a global schedule input, from local schedule or from a group schedule.
   2) Outside air temperature shall be available from a global broadcast for local control options.

C. Zone Temperature Setpoint Control
   1) Zone sensor shall include setpoint adjustment, timed local override, and display (except restroom zones, halls, and other areas where local user adjustment would not be preferred).
      a) Default setpoint adjustment will be ±1°F and timed override will be 30 minutes per user button press with a maximum override of 180 minutes. Adjustment values and override times shall be programmable for each sensor.
   2) Zone setpoint control uses a modified Zone PID algorithm to provide a smooth, modulated variable for cooling and heating.
   3) Default Setpoint Values (adjustable per zone):
      a) When Scheduled Occupied:
         i) Occupied Cooling Setpoint = 74°F.
         ii) Occupied Heating Setpoint = 70°F
      b) When Scheduled Unoccupied:
         i) Unoccupied Cooling Setpoint = 85°F.

ii) Unoccupied Heating Setpoint = 55°F.

D. Supply Fan Control
1) The supply fan will be enabled to run continuously whenever zone is operating in an occupied mode and will cycle on for heating to maintain unoccupied zone setpoints.
2) Fan status will be monitored. (See Safeties and Alarms below)
3) Heating and Cooling will be disabled until fan status is proven.

E. Cooling Control with Modulating Chilled Water Valve
1) On rise of temperature to cooling setpoint, the CHW valve shall modulate (0-100%) to maintain zone temperature based on the output of the Zone Cooling PID.

F. Heating Control with Modulating Hot Water Valve
1) On fall of temperature to heating setpoint, the HW valve shall modulate (0-100%) to maintain zone temperature based on the output of the Zone Heating PID.
2) Heating will be locked out when outside air temperature is above 65°F.

G. Safeties and Alarms
1) Zone Temperature Alarm
a) Zone control shall alarm on high or low zone temperature.
b) Zone Temperature alarms will be disabled during Optimal Start, first 30 minutes of scheduled occupancy or during Setback override.
2) Supply Air Temperature Alarm
a) Supply air temperature monitor shall be included and shall alarm on high or low supply air temperature differential from space temperature.
3) Fan Motor Status Alarm
a) BAS will monitor fan status via a current sensing switch (CT). If fan has been commanded to run by the BAS and the fan status is not indicated, BAS will generate an alarm.

H. BAS Graphics will include the following
1) Outside air temperature
2) Zone temperature/user offsets
3) Heating and cooling setpoints/deadbands
4) Supply air temperature
5) Fan status/start/stop
6) Condensate alarm
7) Chilled water valve position
8) Hot water valve position

2.4 Zone Air Handling Unit

A. This sequence applies to zone AHU-1, 2 ,3 ,4, 5, & 6.

B. Run Conditions
1) Zone shall have independent schedule capability. Scheduling shall be from a global schedule input, from local schedule or from a group schedule.
2) Outside air temperature shall be available from a global broadcast for local control options.

C. Zone Temperature Setpoint Control

1) Zone sensor shall include setpoint adjustment, timed local override, and display (except restroom zones, halls, and other areas where local user adjustment would not be preferred).
   a) Default setpoint adjustment will be ±1°F and timed override will be 30 minutes per user button press with a maximum override of 180 minutes. Adjustment values and override times shall be programmable for each sensor.
2) Zone setpoint control uses a modified Zone PID algorithm to provide a smooth, modulated variable for cooling and heating.
3) Default Setpoint Values (adjustable per zone):
   a) When Scheduled Occupied:
      i) Occupied Cooling Setpoint = 74°F.
      ii) Occupied Heating Setpoint = 70°F
   b) When Scheduled Unoccupied:
      i) Unoccupied Cooling Setpoint = 85°F.
      ii) Unoccupied Heating Setpoint = 55°F.

D. Supply Fan Control
   1) The supply fan will be enabled to run continuously whenever zone is operating in an occupied mode and will cycle on for heating to maintain unoccupied zone setpoints.
   2) Fan status will be monitored. (See Safeties and Alarms below)
   3) Heating and Cooling will be disabled until fan status is proven.

E. Cooling Control with Modulating Chilled Water Valve
   1) On rise of temperature to cooling setpoint, the CHW valve shall modulate (0-100%) to maintain zone temperature based on the output of the Zone Cooling PID.

F. Heating Control with Modulating Hot Water Valve
   1) On fall of temperature to heating setpoint, the HW valve shall modulate (0-100%) to maintain zone temperature based on the output of the Zone Heating PID.
   2) Heating will be locked out when outside air temperature is above 65°F.

G. Safeties and Alarms
   1) Zone Temperature Alarm
      a) Zone control shall alarm on high or low zone temperature.
      b) Zone Temperature alarms will be disabled during Optimal Start, first 30 minutes of scheduled occupancy or during Setback override.
   2) Supply Air Temperature Alarm
      a) Supply air temperature monitor shall be included and shall alarm on high or low supply air temperature differential from space temperature.
   3) Fan Motor Status Alarm
      a) BAS will monitor fan status via a current sensing switch (CT). If fan has been commanded to run by the BAS and the fan status is not indicated, BAS will generate an alarm.

H. Economizer Control
   1) Cooling Control
      a) Economizer Cooling will be enabled when the following conditions are met:
         i) Outside air temperature is more than 4° F below return air temperature
         ii) Supply fan is commanded on

iii) Supply fan status is on

b) Economizer will be controlled from the same PI control loop output as mechanical cooling.

c) Cooling PID control output will modulate the Economizer to maintain SAT at SA setpoint.

d) A mixed air low limit of 50°F will be maintained by a PID control loop.

e) Economizer will be disabled when outside air temperature is less than 1° F below return air temperature. When disabled, OA and RA dampers will be controlled by minimum air position as noted below.

f) Supply air low limit will close outside air dampers if SA falls below 42°F.

g) Economizer will close during unoccupied periods of operation, supply fan fails to prove status, or freeze protection is active.

h) If mixed air temperature falls below 36°F for more than 5 minutes OA dampers will fully close and RA dampers will open. Fan and heating valve will continue to operate and an alarm will be generated.

i) If mixed air temperature remains below 36°F for an additional 5 minutes SA and RA fans will be disabled and HW valve will open to 100% open and an addition alarm will be generated.

2) Minimum damper position

a) System will have a fixed absolute minimum damper setpoint CFM either set by the Test and Balance Contractor, or the required flow to offset normal building exhaust.

I. BAS Graphics will include the following

1) Outside air temperature
2) Zone temperature/user offsets
3) Heating and cooling setpoints/deadbands
4) Supply air temperature
5) Fan status/start/stop
6) Condensate alarm
7) Chilled water valve position
8) Hot water valve position

2.5 VAV Air Handlers

A. This sequence applies to AHU-1 & 2.

B. General

1) Each VFD will be monitored by DDC for start/stop/speed/status and alarm. Refer to

C. Run Conditions

1) System will operate based on requests from zone served by this unit. Outside air temperature from a LAN broadcast is available for control options. Optimal start is based on optimal start requests from the zones. Optimal stop will shut down the unit 5 minutes before the last VAV box goes into setback.

D. Supply Fan Control

1) The supply fan will be continuously enabled whenever any zone is operating in an occupied mode and will cycle on zone demand for cooling to maintain unoccupied zone setpoints. If supply air flow from the AHU is required for unoccupied heating at the zones, the fan will cycle on demand for zone heating to maintain unoccupied zone heating setpoints.
2) Supply Fan VFD will modulate to maintain supply air static pressure setpoint.

3) Each Fan motor status will be monitored. (see Safeties and Alarms section below)
4) Master VFD will be have status monitored directly from VFD as well as BACnet interface points for alarms, runtime, amps, current, etc. Exact interface points will be coordinated between BAS engineer and VFD provider/manufacturer.

E. Supply Air Static Pressure Setpoint Reset
1) Static pressure setpoint will be established using trim and respond logic to increase or decrease setpoint input to a PI logic controller. The PI logic controller will modulate fan speed to maintain setpoint.
2) Initial static pressure setpoint will be 0.5" wc.
3) Maximum static pressure setpoint (P-Max) will be determined as follows
a) Set all VAV boxes to maximum occupied cfm.
i) Set all VAV boxes to maximum air flow.
ii) Starting at 0.5" static pressure, adjust fan speed up until all boxes can maintain maximum occupied cfm.
iii) The pressure required for all boxes to maintain maximum air flow will be P-Max.
4) Reset between 0.5” and P-Max will be as follows:
a) Whenever any 2 VAV boxes are 100% open, pressure setpoint will be increased by 0.05" wc every 5 minutes until the P-Max is met or only 1 VAV box is 100% open.
b) If only one VAV box is at 100% pressure setpoint reset will be stopped and setpoint will remain at current setpoint.
c) When all VAV boxes are reporting less than 100% open, the pressure setpoint will decrease by 0.05" every 5 minutes until setpoint is 0.5” or any individual VAV box again reaches 100% open.

A. Building Static Control w/Return Fan and Relief Damper Control
1) A static pressure sensor in the discharge of the return fan will provide input to a PI control loop to modulate the return fan VFD speed to maintain .01” wc setpoint at the fan outlet.
2) A building space pressure sensor will provide input to a PI control loop to modulate the relief dampers to maintain a build static pressure setpoint of 0.03” wc.
3) Each Fan motor status will be monitored. (see Safeties and Alarms section below)
4) Master VFD will be have status monitored directly from VFD as well as BACnet interface points for alarms, runtime, amps, current, etc. Exact interface points will be coordinated between BAS engineer and VFD provider/manufacturer.
5) The return fan will not be allowed to run if both return air and relief air dampers are fully closed.
6) A high static pressure switch installed in the return fan discharge duct will trip the return fan if static pressure rises above 3.5”wc

B. Supply Air Temperature Setpoint Reset
1) Occupied Mode
a) The following SA temperature reset sequences will be enabled when two or more zone send Occupied Run Requests to the AHU
b) SA Temperature Setpoint will be reset based on the zone cooling PIDs for all VAV zones served by that AHU

c) Initial SAT Setpoint will be 75°F to prevent economizer cooling.
d) When any zone's cooling PID demand rises above 10%, the SA setpoint will be reset to 68°F.
e) When any two zones reach 100% cooling demand, the SAT setpoint will be reset down 1°F every five minutes. Minimum SA setpoint is 55° F.
f) When only one zone PID is at 100% the setpoint will be held at the last reset setpoint.
g) When all zone PIDs are below 100%, the SA setpoint will be reset up 1° every five minutes until setpoint reaches 68°.
h) If all zone PIDs fall below 10%, the SA setpoint will be reset to 75°.
i) The zone cooling demand percent will be requested no less than every 3 minutes

2) Unoccupied Mode
a) When all zones served by this AHU are unoccupied, and a request for cooling is received from two or more zones, SA cooling setpoint will be reset to 55°
b) When all zones served by this AHU are unoccupied, and a request for heating is received from any non-fan powered VAV box, SA heating setpoint will be reset to 90°.
c) Unoccupied Heating requests will take priority over cooling requests.

3) Morning Warm Up
a) When Morning Warm Up request is received from two or more zones, SA setpoint will be reset to 90° and cooling will be disabled.
b) Morning Warm Up requests will take priority over cooling requests.

4) Night Purge
a) When a Night Purge Request is received from any associated zone SA setpoint will be reset to 50°. Mechanical cooling will be disabled.

C. Economizer Control
1) Cooling Control
a) Economizer Cooling will be enabled when the following conditions are met:
i) Outside air temperature is more than 4° F below return air temperature
ii) Supply fan is commanded on
iii) Supply fan status is on
b) Economizer will be controlled from the same PI control loop output as mechanical cooling.
c) Cooling PID control output will modulate the Economizer to maintain SAT at SA setpoint.
d) A mixed air low limit of 50°F will be maintained by a PID control loop.
e) Economizer will be disabled when outside air temperature is less than 1° F below return air temperature. When disabled, OA and RA dampers will be controlled by minimum air position as noted below.
f) Supply air low limit will close outside air dampers if SA falls below 42°F.
g) Economizer will close during unoccupied periods of operation, supply fan fails to prove status, or freeze protection is active.
h) If mixed air temperature falls below 36°F for more than 5 minutes OA dampers will fully close and RA dampers will open. Fan and heating valve will continue to operate and an alarm will be generated.
i) If mixed air temperature remains below 36°F for an additional 5 minutes SA and RA fans will be disabled and HW valve will open to 100% open and an addition alarm will be generated.

2) Minimum damper position
   a) System will have a fixed absolute minimum damper setpoint CFM either set by the Test and Balance Contractor, or the required flow to offset normal building exhaust.

D. Cooling Control – Chilled Water (CHW)
   1) Mechanical Cooling will be enabled when the following conditions are met:
      a) Outside air temperature is greater than 62°F
      b) Supply fan is commanded on
      c) Supply fan status is on
      d) Night Flush is not enabled
   2) SA Temperature input to the cooling PI controller will modulate the CHW valve based on percentage output to meet cooling SA setpoint as follows:
      a) When economizer cooling is available CHW valve will modulate from 0% to 100% as cooling PID rises from 50% to 100%.
      b) When economizer cooling is unavailable CHW valve will modulate from 0% to 100% as cooling PID rises from 0% to 100%.
   3) A cooling request will be sent to the chilled water system when CHW valve is greater than 10% open.

E. Heating Control w/Hot Water
   1) Heating will be activated whenever heat is required for morning warmup or to temper ventilation air when OA conditions and air flow quantities require heat.
   2) When SA temperature falls below heating setpoint the heating PI control loop output will modulate the output to the HW valve between 0 and 100% as SA heating PID varies between 0 and 100%.
   3) Heating will be locked out when outside air temperature is above 65°F.

F. Safeties and Alarms
   1) Hardwired Safeties
      a) The following Safeties will be wired in series with fan contactors/starters to shut down the Supply Fan and Return/Relief Fan when contact opening indicates an alarm condition.
      b) Freeze Stat
         i) An auxiliary contact will be wired to an BAS module and will initiate the following:
            1) Redundant fans shutdown
            2) Close outside air/relief air/exhaust air dampers and open return air dampers
            3) Open hot water valves to 100%
         ii) Freeze stats require a manual reset at device as well as a software reset.
      c) High Static Pressure Switch at fan discharge
         i) An auxiliary contact will be wired to BAS module and will initiate redundant fans shutdown
         ii) High Static safeties require a software reset.
      d) Local Fire/Smoke Alarm
         i) An auxiliary contact will be wired to BAS module and will initiate redundant fans shutdown
      e) All safeties above will generate BAS alarm when tripped.
   2) Fan motor status will be monitored. If supply fan has been commanded to run by BAS and the fan status is not indicated, the BAS will send an alarm to the operator workstation.

3) The Supply Air Temperature sensor will monitor SAT and initiate a low temperature alarm when SAT falls below 42°F for more than 10 minutes while fan status is proven. This alarm requires software reset.
4) Building static pressure high and low alarms are available if desired.
5) Filter status will be monitored with a differential pressure sensor across filter bank. Upon indication that filters need replaced (high DP), or filters are missing or damaged (low DP), an alarm will be generated.

G. BAS Graphics will include the following
1) Outside air temperature
2) System graphic. Each AHU.
3) System on-off indication.
4) System occupied/unoccupied mode.
5) Supply fans on-off, alarm, speed indication.
6) Return fans on-off, alarm, speed indication.
7) Preheat-coil air-temperature indication.
8) Preheat-coil air-temperature setpoint.
9) Preheat-coil control-valve position. (All valves)
10) Mixed-air-temperature indication.
11) Mixed-air-temperature setpoint.
12) Mixed-air damper position.
13) Cooling-coil air-temperature indication.
14) Cooling-coil air-temperature setpoint.
15) Cooling-coil control-valve position.
16) Supply -discharge air-temperature indication.
17) Supply -discharge air-temperature setpoint.
18) Supply-fan-discharge static-pressure indication.
19) Supply-fan-discharge static-pressure reset schedule.
20) Supply-fan-discharge static-pressure setpoint.
21) Supply-fans speed. Each VFD.
22) Return-fans speed. Each VFD.
23) Building static-pressure indication.
24) Building static-pressure setpoint.
25) High static limit setpoint and alarm
26) Low static limit setpoint and alarm

2.6 Building Hot Water System

A. Boiler Controls
1) System has 2 boilers, each has a controller and shall be connected as directed by manufacturer to BAS. BAS Contractor to wire control interface between boilers.
2) On call for heating water the main loop pump P-7 VFD shall be started. If lead pump fails to start, the lag pump P-8 shall be started and alarms shall be sent to BAS. A sensor at the end of loop shall modulate VFD to maintain 5 psi differential between supply and return.
a) Once flow is verified a signal shall be sent to the master boiler controller to enable heat. Boilers respective pump shall be started and after proof of flow boiler shall fire.
b) Boiler control panel shall control and sequence both boilers and their respective pumps as required to fire in the most efficient manner. The boiler loop shall be reset based on outside air temperature from 140°F @

0°F OAT to 110°F @ 60°F OAT (adj). Refer to boiler specification for sensors and equipment provided by boiler manufacturer.

c) Provide lead/lag schedule with alternation for pumps P-7 and P-8 with user selectable schedule for even wear.

B. Heating Water Loop Controls

1) On call for hot water the lead pump shall start. Pump VFD shall modulate to maintain 5 psi differential (adj) at furthest point from pump. Provide lead/lag with alarm on pumps. Rotate lead/lag pumps for equal wear.
2) Loop supply temperature shall be maintained by heating boiler control panel to temperature required by zone or reheat requiring most heat. An Onicon F1210 flowmeter with system 10 BACnet, BTU meter and sensors in loop shall measure flow and BTU used. An Onicon F1210 flowmeter in loop bypass shall be used to verify flow in loop and modulate normally open bypass valve at end of loop to maintain minimum pump flow (30% adj).

C. BAS Graphics will include the following

1) Outside air temperature
2) Boiler start/stop/status/alarm
3) Pump start/stop/status/speed/alarm – each pump
4) Lead/Lag schedule
5) Loop setpoint
6) Loop temperatures
7) Loop flow
8) Minimum flow setpoint
9) Minimum flow
10) Reset schedule
11) Btu used
12) Bypass flow
13) Bypass valve position
14) Differential loop pressure setpoint and pressure.
15) Boiler Glycol Feed System
    a) Glycol tank low level
    b) System pressure
    c) Glycol controller failure

D. Modbus* Integration from Boiler Master Panel (*protocol not confirmed)

1) Exact points will be coordinated between BAS engineer and boiler management system manufacturer. Expected points include:
    a) Alarms
    b) All other applicable values

2.7 Building Chilled Water System

A. NOTE: BAS to daisy chain controller of each chiller module with twisted 2 conductor shielded cable. Verify requirements. BAS to program speed of valves and sequence unit shutdown minimum 6-10 minutes to prevent sudden load changes per chiller manufacturer requirements to slow reaction time and allow chiller modules to unload.

B. DDC system shall canvas chilled water valves and on a call for chilled water the lead chilled water pump P-1 VFD shall be started. If lead pump fails to start the lag pump P-2 VFD shall be started and alarms shall be sent to the BAS. Provide lead/lag/alternation on the pumps P-1 and P-2 with user selectable schedule.

C. Upon proof of flow, a signal shall be sent to the chiller to start.

D. Chiller shall maintain loop temperature required by staging modules using its own controls.

E. BAS Graphics will include the following
   1) Outside air temperature
   2) Pump start/stop/speed/status/alarm (both pumps)
   3) Pump lead/lag/alternation schedule/alarm
   4) Chilled water setpoint
   5) Chilled water temperature
   6) Chiller barrel pressure differential
   7) Pump pressure differential control setpoint.
   8) Chiller start/stop/status/alarm via interface
   9) Chilled water temperature into chiller
   10) Chilled water temperature out of chiller
   11) Chilled water temperature setpoint

F. MS/TP* Integration from Chiller Master Panel (*protocol not confirmed)
   1) Exact points will be coordinated between BAS engineer and boiler management system manufacturer. Expected points include:
      a) Alarms
      b) All other applicable values

END OF SECTION 23 0953

SECTION 23 2113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. This Section includes piping, special-duty valves, makeup water for these systems; blowdown drain lines; and condensate drain piping.

1.3 SUBMITTALS

A. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.

B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.

E. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 23.

F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.4 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

C To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved

components.

1.5 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

1.6 EXTRA MATERIALS

A. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grooved Mechanical-Joint Fittings and Couplings:
      a. Central Sprinkler Company; Central Grooved Piping Products.
      b. Grinnell Mechanical Products.
      c. Victaulic Company of America.
   2. Calibrated Balancing Valves:
      a. Armstrong Pumps, Inc.
      b. Flow Design, Inc.
      c. Gerand Engineering Company.
      d. Griswold Controls.
      e. ITT Bell & Gossett; ITT Fluid Technology Corp.
      f. Taco, Inc.
      g. Tour Andersson supplied by Victaulic
   3. Pressure-Reducing Valves:
      a. Amtrol, Inc.

b. Armstrong Pumps, Inc.
c. Conbraco Industries, Inc.
d. ITT Bell & Gossett; ITT Fluid Technology Corp.
e. Spence Engineering Company, Inc.
f. Watts Industries, Inc.; Watts Regulators.

4. Safety Valves:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Conbraco Industries, Inc.
   d. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
   e. Kunkle Valve Division.
   f. Spence Engineering Company, Inc.
5. Automatic Flow-Control Valves:
   a. Flow Design, Inc.
   b. Griswold Controls.
6. Expansion Tanks:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. ITT Bell & Gossett; ITT Fluid Technology Corp.
   d. Taco, Inc.
7. Air Separators and Air Purgers:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. ITT Bell & Gossett; ITT Fluid Technology Corp.
   d. Taco, Inc.

2.2 PIPING MATERIALS

A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

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

F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

A. Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40, black steel, plain ends.

B. Steel Pipe, NPS 2-1/2 through NPS 12: ASTM A 53, Type E (electric-resistance

welded), Grade B, Schedule 40, black steel, plain ends.

C. Steel Pipe, NPS 14 through NPS 18: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 30, black steel, plain ends.

D. Steel Pipe, NPS 20: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 20, black steel, plain ends.
   1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.

E. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.

F. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

G. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

H. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

I. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

J. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

K. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.

L. Standard Mechanical Couplings, 2 inch through 12 inch: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa).
   a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.
      1. 2 inch through 12 inch: Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade EPDM compound designed for operating temperatures from -30 deg F to +250 deg F. Gasket temperature rating shall be met without the use of special lubricants.
   b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at

equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.

1. 2” through 8”: Installation-ready flexible coupling for direct stab installation without field disassembly. Gasket shall be grade EPDM compound designed for operating temperatures from -30 deg F to +250 deg F. Gasket temperature rating shall be met without the use of special lubricants.
2. 10” through 12”: Standard flexible couplings. Gasket shall be Grade “E” EPDM compound designed for operating temperatures from -30 deg F to +230 deg F.

M. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

N. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

O. Packed, Slip, Expansion Joints: 150-psig minimum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, packing ring, packing, limit rods, flanged ends, and chrome-plated finish on slip-pipe telescoping section.

P. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

Q. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 VALVES

A. Gate, globe, check, ball, and butterfly valves are specified in Division 23 Section "Valves."

B. Grooved-End Butterfly Valves
   1. 2" through 12" Sizes: 300 psi CWP suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree circumferential seating. Seat shall be pressure responsive EPDM. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat. Valve shall be complete with ISO flange for actuation mounting. Valve operators shall be lever handle or gear operator, available with memory stop feature, locking device, chainwheel, or supplied bare. (Valve with EPDM seat is UL classified in accordance with ANSI/NSF-61.)

C. Grooved-End Check Valves
   1. 2 inch through 12 inch sizes: Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc

suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi. Valve with pre-tapped ports as available option.

D. Refer to Part 3 "Valve Applications" Article for applications of each valve.

E. Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.

F. Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.

G. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

H. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

I. Automatic Flow-Control Valves: Gray-iron body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Valve shall be line size and one of the following designs:
   1. Gray-iron or brass body, designed for 175 psig at 200 deg F with stainless-steel piston and spring.
   2. Brass or ferrous-metal body, designed for 300 psig at 250 deg F with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
   3. Combination assemblies, including bronze ball valve and brass alloy control valve, with stainless-steel piston and spring, fitted with pressure and temperature test valves, and designed for 300 psig at 250 deg F.

2.6 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.

C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and

375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Include the following fittings and accessories:

1. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Design tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
2. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; designed to admit air to compression tank, drain water, and close off system.
3. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.

D. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a flexible bladder securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

E. Tangential-Type Air Separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.

F. In-Line Air Separators: One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 175 psig and liquid temperature up to 300 deg F.

G. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig and temperature of 250 deg F.

H. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

I. Diverting Fittings: 125-psig working pressure; 250 deg F maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.

J. Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.

K. Grooved Y-Pattern Strainer: 2 inch through 18 inch sizes, 300 PSI Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" (1,6mm) diameter perforations 2"-

3" strainer sizes, 1/8" (3,2mm) diameter perforations 4"-12" strainer sizes, and 0.156" (4mm) diameter perforations 14" -18" strainer sizes. Strainer basket shall be accessed by removal of mechanical coupling.

L. Basket Strainers: 125-psig working pressure; high-tensile cast-iron body (ASTM A 126, Class B), flanged-end connections, bolted cover, perforated stainless-steel basket, and bottom drain connection.

M. T-Pattern Strainers: 750-psig working pressure; ductile-iron or malleable-iron body, grooved-end connections, stainless-steel basket with 57 percent free area; removable access coupling and end cap for strainer maintenance.

N. Grooved T-Pattern Strainer: 2" through 12" sizes, 300 PSI T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-45-12) body, Type 304 stainless steel frame and mesh removable basket with No. 12 mesh, 2"-3" strainer sizes, or No. 6 mesh, 4"-12" strainer sizes, 57% free open area. Strainer basket shall be accessed by removal of mechanical coupling.

O. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

P. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

Q. Packed, Slip, Expansion Joints: 150-psig minimum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, packing ring, packing, limit rods, flanged ends, and chrome-plated finish on slip-pipe telescoping section.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Chilled Water, NPS 2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints. Belowground or within slabs, use Type K annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs.

B. Chilled Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded and flanged joints.

C. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints or Schedule 40, PVC pipe with solvent-welded joints.

3.2 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
   1. Shutoff Duty: Gate, ball, and butterfly valves.
   2. Throttling Duty: Globe, ball, and butterfly valves.

B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

C. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.3 PIPING INSTALLATIONS

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.

B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

G. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

H. Anchor piping for proper direction of expansion and contraction.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer. cal runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.

3.6 HYDRONIC SPECIALTIES INSTALLATION

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

B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.

C. Install dip-tube fittings in boiler outlet. Install piping to expansion tank with a 2 percent upward slope toward tank. Connect boiler-outlet piping.

D. Install in-line air separators in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install drain valve on units NPS 2 and larger.

E. Install combination air separator and strainer in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install blowdown piping with gate valve; extend to nearest drain.

F. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.

G. Install expansion tanks above air separator. Install gage glass and cocks on end of tank. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   1. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, and fittings, plus weight of a full tank of water. Do not overload building components and structural members.

H. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be same as for equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If multiple, parallel control valves are installed, only one bypass is required.

D. Install ports for pressure and temperature gages at coil inlet connections.

3.8 CHEMICAL TREATMENT

A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

B. Fill system and perform initial chemical treatment.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush system with clean water. Clean strainers.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
   6. Grooved pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
   7. The grooved couplings gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
   8. Grooved couplings installation shall be complete when visual metal-to-metal contact is reached.

3.10 GROOVED PIPING TRAINING

A. A factory trained representative (direct employee) of the grooved coupling supplier shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation.

PART 4 - Testing

A. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
   3. Check expansion tanks to determine that they are not air bound and that system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any

vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

4.8 ADJUSTING

A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

B. Perform these adjustments before operating the system:
1. Open valves to fully open position. Close coil bypass valves.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
8. Lubricate motors and bearings.

4.9 CLEANING

A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 23 2113

SECTION 23 2118 – BACKFLOW PREVENTER VALVE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install a backflow preventer valve as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Designed to provide separation of radiant hot water heating system water from domestic cold water supply in accordance with Code.
   1. Rated flow at 30 psi pressure drop rated for 175 psi inlet pressure and 140 deg. F maximum operating temperature.
   2. Brass body construction with 3/4 inch NPT connections.

B. Approved Manufacturers:
   1. Beeco 12
   2. Watts 900
   3. Equal by Febco
   4. Equal by Conbraco

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install a drain cup and pipe the waste line to the nearest floor drain or floor sink.

END OF SECTION 23 2118

SECTION 23 2123 – CIRCULATING PUMPS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 22 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install circulating water pumps and accessories as described in the Contract Documents.

PART 2 - PRODUCTS

2.1 BASE MOUNTED PUMPS

A. Packless flexible coupled, end suction vertically split case design to facilitate servicing all internal components without disturbing pump, volute or motor. The pump volute shall be supplied with plugged vent, drain, and gage tappings. The pump casing shall be of Class 30 cast iron, suitable for 175 PSI working pressure.

B. The pump and motor shall be mounted or a common base plate of heavy structural steel design and securely welded cross members and open grouting area. Securely bolted to isolation base as specified and to the 6-inch high concrete base. Weight of piping shall not be supported on pumps. The pump shall be factory tested before shipment.

C. The motor shall beet NEMA specifications and shall be the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the Contractor after installation prior to start up.

D. 1750 rpm with bronze impeller, wearing rings, stainless steel shaft, and ceramic seal. The pump bearings shall be the regreasable camlock ball bearing type with provision for purging or flushing through the bearing surface, and capable of being inspected by removing the bearing cover. The shaft shall be of 18-8 stainless steel on standard mechanical seal models.

E. Internally-flushed seals shall be mechanical type with ceramic seal and carbon ring, suitable for continuous operation at 225 deg. F. The seals shall be capable of being serviced without disconnecting the pump from piping.

F. Impeller shall be of the enclosed end-suction type in bronze construction and shall be dynamically balanced for quiet operation. Impeller shall be shaved to provide exact operating point specified on drawings. Motor size shall be as shown on drawing but if an alternate pump is supplied that could operate in the overload range, a large motor shall be furnished. Motor shall not operate overloaded. Any additional electrical cost for oversized motor shall be borne by pump manufacturer’s representative.

G. A flexible, Center Drop-out spacer type coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Coupler shall be shielded

by a Coupler Guard securely fastened to the base.

H. Approved Manufacturers:
1. Bell & Gossett
2. Armstrong
3. Grundfos

2.2 PUMP SUCTION DIFFUSERS:

A. Match system pipe size and pump inlet size shall be furnished and installed where shown on drawings.

B. Angle type body with inlet vanes and combination diffuser-strainer-orifice cylinder.

C. Approved Manufacturers:
1. Bell & Gossett
2. Armstrong
3. Or approved equal

2.3 TRIPLE DUTY VALVES

A. Place on each pump discharge. Valve serves as a non-slam check valve with spring loaded disk check, calibrated adjustable and lockable balance valve and full shutoff valve with memory stop. Valve shall be back-seated so as to allow repacking under full line pressure.

B. Cast iron body

C. Bronze disk and seat with stainless steel stems and springs.

D. Teflon packing

E. Maximum valve working pressure of 175 psig and a maximum operating temperature of 300 deg. F.

F. Approved Manufacturers:
1. Bell & Gossett
2. Armstrong

2.4 EXPANSION JOINT PUMP CONNECTORS

A. Precision machine molded neoprene and nylon construction internal reinforced by means of steel wire.

B. Cadmium steel floating flanges tapped to mate with 150# ASA companion flanges.

C. Capable of operating at a temperature of 20 deg. F. thru 220 deg. F. and at a pressure ranging from 10" HG vacuum thru 150 psi working pressure.

D. Capable of 15 deg. angular deflection.

E. Twin quiet-sphere design with control rods.

F. Approved Manufacturers:
   1. Vibration Mountings & Controls, Inc.
   2. Metraflex

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturers instructions.

B. Align pump and motor shafts in accordance with manufacturers requirements before starting equipment. Provide report in the M&O manual regarding pump alignment.

C. Remove start-up filter screen on suction diffuser after system has been cleaned and flushed. Leave main filter screen in place.

END OF SECTION 23 2123

SECTION 23 2125 - CLEANING AND FLUSHING WATER CIRCULATING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish labor and materials to thoroughly clean water circulating systems as described in Contract Documents.

B. Mechanical contractor shall procure the services of an independent treatment contractor as described in this specification.

1.3 QUALITY ASSURANCE

A. System Additives: This Contractor shall not add any water treatment chemicals or "stop-leak" compounds to the system.

PART 2 - EXECUTION

2.1 FIELD QUALITY ASSURANCE

A. Water circulating systems for project shall be thoroughly cleaned before placing in operation to rid system of dirt, piping compound, mill scale, oil, and other materials foreign to water being circulated.

B. During construction extreme care shall be exercised to prevent dirt and other foreign matter from entering pipe or other parts of system. Pipe stored on project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fittings, or valve shall be visually examined and dirt removed.

C. Side Stream Filtration and Flushing Valves
   1. The Mechanical Contractor shall install a bag style side stream filter in the main mechanical room. This filter shall be furnished with 12 clean polyester bags with a filtration rating of 5 micron. The filter shall be sized to provide a pressure drop equal to the pressure drop of the parallel component with 80% flow through the primary component and 20% through the filter. Minimum filter size shall be 18” high and 6” in diameter. If this minimum size allows excessive flow through the side stream filter a balance valve shall be installed to insure sufficient flow through the primary central plant component.
   2. Ball valves of full line size shall be installed at the end of each primary run. The valves shall have a nipple and cap installed.

D. Chilled Water Closed Loop Cleaning
   1. Prior to any introduction of fluids to the closed loop system the Mechanical Contractor shall close isolation valves at each coil and open the bypass valve to

prevent flow through the strainer, flow control device and heat pump during the initial flushing and subsequent cleaning. The side stream filter bag shall be removed during the initial flushing process.

2. The Mechanical Contractor shall fill each hydronic system with clean fresh water prior to cleaning and thoroughly leak check system piping. A cleaning and passivating agent supplied by the Chemical Treatment Contractor shall be added to the system at the direction of the Treatment Contractor during the leak check process to minimize initial corrosion. If the system is filled multiple times during the leak check and repair process the Mechanical Contractor shall coordinate with the Treatment Contractor to maintain this initial protection. The Treatment Contractor is responsible for providing chemical for up to two refills of the system. If additional chemical is required due to multiple refillings the Mechanical Contractor shall be responsible for the additional time and chemical.
3. Following leak check the closed system shall be flushed by the Mechanical Contractor until the leaving water runs clear. All primary runs shall be flushed at their ends to obtain maximum sweep of debris from the system. The inlet screens on the circulating pumps must be kept clear during this initial cleaning process and inspected following cleaning. When flushing is complete the system is to be left full.
4. Prior to flushing the Mechanical Contractor shall coordinate with Treatment Contractor so that the Treatment Contractor can be available immediately following flush and final refill to add cleaning chemical within 4 hours to prevent initial corrosion.
5. Following initial flushing the Chemical Treatment Contractor shall refill all systems with cleaning and passivating agents raising the PH to a minimum of 10, circulate and flush until thoroughly clean. All primary piping runs shall be flushed at the ends during this cleaning process. When boiler operation is available the loop temperature should be raised to 110 to 120° to accelerate cleaning. Cleaning with availability of boiler operation should be anticipated to last 7 to 10 days or longer depending on initial loop conditions. If boiler operation is unavailable loop cleaning duration should be expected to double. The Chemical Treatment Contractor shall verify and adjust cleaning chemistry, and inspect side stream filter bags at a minimum of every two days, exception for weekends. Filter bags shall be changed as required during this cleaning process. Cleaning shall continue until these bags no longer show signs of debris.
6. Following cleaning process the Treatment Contractor shall close the bypass valves at each heat pump and open isolation valves for normal operation and check for leaks of local piping connections. Any leaks found shall be referred to the Mechanical Contractor for repair. The bypass valve handle shall be removed and tied to the valve. The system shall then be charged with final operating chemical to control long term corrosion and a clean bag filter shall be installed in the system.
7. The Treatment Contractor shall provide final inspection report for inclusion in the Operation and Maintenance Manual. Additionally the Treatment Contractor shall take loop samples approximately 12 months following completion, add or adjust chemical as required and provide a post construction report to the owner prior to warranty closeout. Chemical required is the responsibility of the Treatment Contractor.

END OF SECTION 23 2125

SECTION 23 2510 – GLYCOL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install glycol system as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chilled water system shall be a 40% glycol and water system. Furnish and install a manual glycol pump and fill system and fill the chiller, coils and piping system with the solution.

B. Coils, pumps, boiler and piping have been sized to handle the 40% solution.

C. Glycol shall be of a permanent type with rust inhibitors and shall have an identifying odor and color.
   1. Approved Manufacturer:
      a. Dowtherm Type SR-1.

PART 3 - EXECUTION

3.1 Provide warning stickers on equipment and piping indicating the solution in system.

END OF SECTION 23 2510

SECTION 23 2600- CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install condensate drain piping as described in Contract Documents.

B. Related Requirements:
   1. Section 23 0501: Common HVAC Requirements.

1.2 REFERENCES

A. Reference Standards:
   1. ASTM International:
      a. ASTM B 88-03, 'Standard Specification for Seamless Copper Water Tube.'

PART 2 - PRODUCTS

2.1 SYSTEMS

A. Materials:
   1. Condensate Drains:
      a. Schedule 40 PVC for condensate drains from furnace combustion chambers and furnace cooling coils, and auxiliary drain pans.

B. Manufactured Units
   1. Condensate Pump
      a. Rated at 225 gph at 15 feet total head. Complete with one gallon polystyrene tank with pump and automatic float control. 1**/**5 hp, 120 V, one phase, 60 Hertz.
      b. Condensate piping shall be Type M copper or Schedule 40 PVC.
      c. Approved Manufacturers -
         1) No. CU551UL by Beckett Pumps, (888) 232-5388
         2) No. VCL45S by Little Giant Pump Co, Oklahoma City, OK (405) 947-2511

PART 3 - EXECUTION

3.1 INSTALLATION

A. Condensate Drains:
   1. Support piping and protect from damage.
   2. Do not combine PVC condensate drain piping from furnace combustion chamber with copper condensate drain piping from cooling coil.
   3. Do not combine auxiliary drain pan piping with furnace / Cooling Coil Condensate drain piping.

END OF SECTION 22 2600

SECTION 23 3114 - LOW-PRESSURE STEEL DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install above-grade ductwork and related items as described in Contract Documents.

PART 2 - PRODUCTS

2.1 DUCTS

A. Fabricate of zinc-coated lockforming quality steel sheets meeting requirements of ASTM 653A/653M, "Specification for Sheet Steel Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock Forming Quality", with G 60 coating.

B. Use of aluminum, non-metallic, or round ducts is not permitted. [Specification writer: Use of aluminum ducts in areas with high chlorine content (eg.: ventilation for pools, spas, etc.) should be considered on a per job basis.]

2.2 DUCT JOINTS

A. Ducts with sides up to and including 36 inches shall be as detailed in the SMACNA manual.

B. Duct sizes over 36 inches shall be fabricated using SMACNA T-24 flange joints or pre-fabricated systems as follows:
   1. Ducts with sides over 36 inches to 48 inches:
      a. transverse duct joint system by Ductmate/25, Nexus, Ward, or WDCI (Lite) (SMACNA "E" or "G" Type connection).
   2. Ducts 48 inches & larger:
      a. Ductmate/35, Nexus, or WDCI (Heavy) (SMACNA "J" Type connection).
   3. Approved Manufacturers:
      a. Ductmate Industries Inc, 10760 Bay Meadows Drive, Sandy, UT 84092 (801) 571-5308
      b. Nexus, Exanno Corp, P O Box 729, Buffalo, NY 14206 (716) 849-0545
      c. Ward Industries Inc, 1661 Lebanon Church Road, Pittsburg, PA 15236 (800) 466-9374
      d. WDCI, P O Box 10868, Pittsburg, PA 15236 (800) 245-3188

2.3 ACCESS DOORS IN DUCTS

A. At each manual outside air damper and at each motorized damper, install factory built insulated access door with hinges and sash locks. Locate doors within 6 inches of installed dampers. Construction shall be galvanized sheet metal, 24 ga minimum.

B. Fire and smoke damper access doors shall have a minimum clear opening of 12" x 12" or as specified on Drawings to easily service fire or smoke damper. Doors shall be within 6 inches of fire and smoke dampers and in Mechanical Room if possible.

C. Identify each door with 1/2" high letters reading “smoke damper” or “fire damper”.

D. Approved Manufacturers:
   1. AirBalance - Fire/Seal #FSA 100
   2. Air Control Products - HAD-10
   3. Cesco-Advanced Air - HAD-10
   4. Elgen - Model 85 A
   5. Kees Inc - ADH-D.
   6. Louvers & Dampers - #SMD-G-F
   7. Nailor-Hart Industries Inc - Series 0831
   8. National Controlled Air Inc - Model AD-FL-1

2.4 FLEXIBLE EQUIPMENT CONNECTIONS

A. 30 oz closely woven UL approved glass fabric, double coated with neoprene.

B. Fire retardant, waterproof, air-tight, resistant to acids and grease, and withstand constant temperatures of 250 deg F.

C. Approved Manufacturers:
   1. Cain - N-100
   2. Duro Dyne - MFN
   3. Elgen - ZLN
   4. Ventfabrics - Ventglas

2.5 CONCEALED CEILING DAMPER REGULATORS

A. Approved Manufacturers:
   1. Cain
   2. Duro Dyne
   3. Metco Inc
   4. Vent-Lock - #666
   5. Young - #303

2.6 VOLUME DAMPERS

A. In Main Ducts:
   1. 16 gauge galvanized steel, opposed blade type with 3/8 inch pins and end bearings. Blades shall have 1/8 inch clearance all around.
   2. Damper shall operate within acoustical duct liner.
   3. Provide channel spacer equal to thickness of duct liner.
   4. Approved Manufacturers:
      a. Air Balance - Model AC-2
      b. Air Control Products - CD-OB
      c. American Warming - VC-2-AA
      d. Greenheck - VCD-1100
      e. NCA, Safe Air
      f. Vent Products - 5100

B. In Sheet Metal Branch Ducts:
   1. Extruded aluminum, opposed blade type. When in open position, shall not extend beyond damper frame.
   2. Maximum blade length 12 inches.
   3. Damper Regulator shall be concealed type with operation from bottom or with 90 deg miter gear assembly from side.
   4. Approved Manufacturers:
      a. Air Control Products - TCD-OB
      b. Air Guide - OB
      c. Arrow - OBDAF-207
      d. CESCO - CDA
      e. Reliable Metals - OBD-RO
      f. Tuttle & Bailey - A7RDDM
      g. Safe Air
      h. Young - 820-AC

C. Dampers above removable ceiling and in Mechanical Rooms shall have locking quadrant on bottom or side of duct. Otherwise, provide concealed ceiling damper regulator and cover plate.

2.7 DUCT HANGERS

A. 1" x 18 gauge galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 8 feet apart. Do not use wire hangers.

B. Attaching screws at trusses shall be 1-1/2 inch No. 10 round head wood screws. Nails not allowed.

2.8 DUCT SEALER

A. Cain - Duct Butter or Butter Tak

B. Design Polymerics - DP 1010

C. DSC - Stretch Coat

D. Duro Dyne - S2

E. Hardcast - #601 Iron-Grip or Peel-N-Seal Tape
   1. Kingco - 15-325
   2. Mon-Eco - 44-41
   3. Trans-Continental Equipment Co - Multipurpose Duct Sealant
   4. United - Sheet Metal duct-sealer

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ducts:
   1. Straight and smooth on inside with joints neatly finished unless otherwise directed.
   2. Duct panels through 48 inch dimension having acoustic duct liner need not be crossbroken or beaded.

3. Crossbreak unlined ducts and duct panels larger than 48 inch or bead 12 inches on center.
4. Securely anchor ducts to building structure with specified duct hangers attached with screws. Do not hang more than one duct from a duct hanger.
5. Brace and install ducts so they shall be free of vibration under all conditions of operation.
6. Ducts shall not bear on top of structural members.
7. Make duct take-offs to branches, registers, grilles, and diffusers as detailed on Drawings.
8. Ducts shall be large enough to accommodate inside acoustic duct liner. Dimensions shown on Drawings are net clear inside dimensions after duct liner has been installed.
9. Properly flash where ducts protrude above roof.
10. Install internal ends of slip joints in direction of flow. Make joints air tight using specified duct sealer.
11. Cover horizontal and longitudinal joints on exterior ducts with two layers of Hardcast tape installed with Hardcast HC-20 adhesive according to Manufacturer's recommendations.
12. Paint ductwork visible through registers, grilles, and diffusers flat black.

B. Install flexible inlet and outlet duct connections to each furnace, fan, fan coil unit, and air handling unit.

C. Install concealed ceiling damper regulators.
1. Paint cover plates to match ceiling tile.
2. Damper regulators will not be required for dampers located directly above removable ceilings or in Mechanical Rooms.

D. Provide each take-off with an adjustable volume damper to balance that branch.
1. Anchor dampers securely to duct.
2. Install dampers in main ducts within insulation.
3. Dampers in branch ducts shall fit against sheet metal walls, bottom and top of duct, and be securely fastened. Cut duct liner to allow damper to fit against sheet metal.
4. Where concealed ceiling damper regulators are installed, provide a cover plate.

E. Install grilles, registers, and diffusers. Level floor registers and anchor securely into floor.

F. Air Turns:
1. Permanently installed, consisting of single thickness curved metal blades with one inch straight trailing edge to permit air to make abrupt turn without appreciable turbulence, in 90 degree elbows of above ground supply and return ductwork.
2. 4-1/2 inch wide minimum vane rail. Do not use junior vane rails.
3. Double thickness vanes not acceptable.
4. Quiet and free from vibration when system is in operation. See SMACNA Manual

G. Install motorized dampers

END OF SECTION 23 3114

SECTION 23 3115 – VARIABLE AIR VOLUME BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install variable air volume boxes as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Units shall consist of primary air damper, attenuator section, radiated noise shroud, primary air damper actuator and primary air controller.

B. Box Casing:
   1. Fabricated of heavy gauge (min. 22 ga.f) zinc-coated sheet steel.
   2. Lined with 1" glass fiber which conforms to NFPA-90A.
   3. Each box shall be provided with a bottom removal access door of sufficient size to provide access to interior of box.
   4. Primary air volume controller and actuator shall be furnished and installed by box manufacturer.

C. Controls shall be electronic as specified in control section of this specification and shall be enclosed by a zinc-coated sheet steel cover.
   1. Primary air volume controller shall be pressure independent and shall control air volume within plus and minus 5% of design air volume regardless of change in system static pressure. Primary air controller shall reset air volume, as required by thermostat, with the same accuracy.
   2. Reset primary air volume shall not be affected by changes in system static pressure.
   3. Boxes using cfm limiters are not acceptable.
   4. Each box shall be factory set for maximum and minimum cfm.

D. Cfm sensing tubes of the automatic averaging type shall be included in each box inlet. The same sensing tube shall also be used as balancing taps for field adjustment of the maximum (and minimum) primary cfm. The balancing taps shall be used in conjunction with a flow chart of each VF box to permit readjustment of maximum (and minimum) primary air volume if job conditions so dictate. Field readjustment shall be by means of adjustment screws. A schematic drawing shall be affixed to each VF box indicating proper hookups for controls.

E. Approved Manufacturers:
   1. Price
   2. Envrio-tec
   3. Or Approved Equal

END OF SECTION 23 3115

SECTION 23 3182 – HIGH PRESSURE DUCT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install high pressure duct systems as described in Contract Documents.

PART 2 - PRODUCTS

2.1 ROUND AND OVAL

A. Ducts so designated and supplying air to VAV boxes shall be of spiral lockseam conduit. The conduit shall be fabricated from high quality, bright spangled, open-hearth, galvanized steel and shall be formed with a reinforcing rib on the outside filled with sealant and smooth interior. All duct and fittings shall be for 6 inch WG static pressure.

B. Fittings shall be fabricated from galvanized sheets with longitudinal and transverse seams welded and coated inside and out with rust inhibiting paint. Branch take-off from tees and laterals shall be welded to the trunk body by means of everdure welding. The fittings shall be formed with a roll shoulder against which the pipe shall be butted in installation.

C. Pipe and fittings shall be joined using adhesive recommended by the duct manufacturer painted on the male and female end of the pipe and fittings, pushed into place, fastened with No. 7x3/4 sheet metal screws, wrapped with three layers of fiberglass tape, 2 inches wide.

D. Flat-oval ducts shall be installed where shown with fittings of like type and shall be reinforced on the outside with angle iron as detailed and as recommended by the duct manufacturer if the width exceeds twice the height.

E. Vertical duct risers shall be supported at each floor by angle iron welded to ducts and connected to building structure at each floor.

F. High pressure duct and fittings shall be manufactured by same manufacturer and shall have guaranteed pressure ratings.

G. Approved Manufacturers:
   1. Team Mechanical
   2. United Sheet Metal
   3. Lewis Corp.

H. Duct Sealant - SMACNA duct sealant class "A".

2.2 HIGH PRESSURE FLEXIBLE DUCT

A. High pressure flexible duct used upstream of terminal boxes shall be rated UL-181 Class 1 air duct and approved by NFPA 90A and 90B.

B. Thermal conductance: C=.23.

C. Rated for working pressure of 15 inches WG and with a velocity of up to 6,000 FPM.

D. Temperature range rated to 250 deg. F.

E. Core fabric shall be glass fiber reinforced copolymer impregnated through fire retardant fabric with low smoke and flame ratings.

F. Interior:
   1. Smooth with no seams for laminar air flow
   2. Low pressure drop
   3. No dust collecting crevices
   4. Leakproof

G. Insulation shall be 1" x 1# density glass fiber.
   1. Vapor barrier shall be scuff resistant and be cuffed at both ends for overlap.
   2. Joints and connections shall be made with two 1/2" wide positive locking steel or plastic straps. One strap shall attach the inner liner and a second strap shall strap the vapor barrier and insulation so they cover 1" past the inner liner.
   3. Duct tape will not be used.
   4. Approved Manufacturers:

H. Genflex IMPR

PART 3 - EXECUTION

3.1 TESTING

A. High pressure duct system shall be tested in sections after installation.
   1. Test shall consist of placing each sealed section under a pressure of 8 inches WG. Air lost by leakage shall not exceed 1/2% of the total air quantity.
   2. If above test indicates duct leaks beyond conditions specified, joints in ducts shall be treated with soap solution and leaks repaired until above specified conditions are obtained.
   3. Tests shall be conducted in presence of Engineer.

B. Large vertical risers and ducts in fan room shall be tested with system in operation using soap solution to detect leaks. Leaks indicated by actively blowing bubbles shall be repaired.

C. Actual method used shall be as recommended by duct manufacturer.

END OF SECTION 23 3182

SECTION 23 6210 - AIR-COOLED WATER CHILLERS

PART 1 GENERAL

1.1 SCOPE

A. Section includes design, performance criteria, controls and control connections, chilled water connections, electrical power connections and refrigerants of the chiller package.

1.2 REFERENCES

A. Products shall be designed, rated and certified in accordance with applicable sections of the following Standards and Codes:

1. To comply with the most recent versions of applicable Standards and Codes of Air-Conditioning, Heating & Refrigeration Institute (AHRI) 550 / 590.

2. AHRI 370 - Standard for Sound Rating of Large outdoor Refrigerating and Air-conditioning Equipment.

3. To comply with the most recent versions of applicable Standards and Codes of American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 15.

4. Units shall meet the efficiency standards of ASHRAE 90.1.

5. To comply with seismic application in accordance with the most recent versions of the International Building Code (IBC).

1.3 QUALITY ASSURANCE

A. Underwriters' Laboratories (UL) 1995 -- Standard for Heating and Cooling Equipment.

B. Manufactured facility to be International Organization for Standardization (ISO) 9001.

C. Factory Functional Test: The chiller shall be pressure tested, evacuated and fully charged with HFC-410A refrigerant and oil. In addition, a factory functional test to verify correct operation by cycling condenser fans, closing compressor contacts and reading data points from temperature and pressure sensors.

D. Operational Test with Water: Chiller shall be functionally tested with power and water flowing through the chiller before shipment. A test report showing date and time of test shall be provided.

E. Chiller manufacturer shall have a factory trained and supported service organization that is within a 150 mile radius of the site.

F. Warranty: The manufacturer shall warrant all equipment and material of its manufacture against defects in workmanship and material for a period of one year from date of initial start-up or eighteen months from date of shipment; whichever

occurs first.

1.4 SUBMITTALS

A. Submit shop drawings and product data in accordance with the specifications.

B. Submittals shall include the following:

1. Dimensioned plan and elevation view drawings, required clearances, and location of all field connections.

2. Product data indicating rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

1.5 OPERATION AND MAINTENANCE DATA

A. Include manufacturer's descriptive literature, installation checklist, start-up instructions and maintenance procedure.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Units shall be delivered to job site fully assembled and charged with refrigerant (unless selected with nitrogen charge) and oil by the manufacturer.

B. Unit shall be stored and handled per manufacturer's instructions.

C. During shipment, provide protective covering over vulnerable components. Fit nozzles and open pipe ends with enclosures.

D. Unit controls shall be capable of withstanding 158F (70C) storage temperature in the control compartment for an indefinite period of time.

1.7 WARRANTY

A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

B. A 5-year motor/transmission/compressor warranty shall be provided based upon the RPM of the compressors as follows:

Compressor RPM	Warranty Term
0 - 5000	1 year from start-up
5001 - 10,000	5 years from start-up
10,001 and above	5 years plus annual oil analysis

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Trane Model RTAF [See drawings for capacity]

B. Or Approved Equal from Carrier, or York

C. Others require prior approval a minimum of 7 days prior to bid opening.

2.2 GENERAL UNIT DESCRIPTION

A. Factory assembled, single-piece chassis, air-cooled liquid chiller. Contained within the package shall be all factory wiring, piping, controls, and refrigerant charge (HFC-410A).

2.3 CABINET

A. Frame shall be heavy-gage, with a powder coated paint finish for both aesthetic appeal and to offer more resistance to corrosion.

B. Units shall be constructed of a galvanized steel frame with galvanized steel panels and access doors. Component surfaces shall be finished with a powder-coated paint. The coating or paint system shall withstand a 500-consecutive-hour salt spray application in accordance with standard ASTMB117.

2.4 COMPRESSORS

A. Fully hermetic scroll type compressors with R410A optimized and dedicated scroll profile.

B. Direct drive motor cooled by suction gas with only three major moving parts and a completely enclosed compression chamber which leads to increased efficiency.

C. Each compressor shall have overload protection internal to the compressor

D. Each compressor shall include: centrifugal oil pump, oil level sight glass and oil charging valve

E. Each compressor will have crankcase heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

2.5 EVAPORATOR

A. The evaporator shall be a high efficiency, brazed plate-to-plate type heat exchanger consisting of parallel plates. Braze plates shall be stainless steel with copper braze material.

B. The evaporator shall be protected with an etched foil heater and covered with insulation. This combination shall provide freeze protection down to -20F (-6.67C) ambient temperatures while the heater is powered. Contractor shall provide separate power to energize heater and protect evaporator while chiller is disconnected.

C. The water side working pressure shall be rated at 150 psig (10.3 bar) and tested at 1.5 times maximum allowable water side working pressure.

D. The refrigerant side working pressure shall be rated at 460 psig (29.6 bars) and

tested at 1.1 maximum allowable refrigerant side working pressure.

2.6 CONDENSER

A. Construct condenser coils of microchannel all aluminum brazed fin construction. The condenser coils shall have an integral sub-cooling circuit and shall be designed for at least 650 psig (44.8 bar) working pressure. Leak tested at 715 psig (49.3 bar). Coils can be cleaned with high pressure water.

B. The maximum allowable working pressure of the condenser shall be 650 psig (44.8 bars). The condensers shall be factory proof and leak tested at 715 psig (49.3 bars).

C. Low Sound Fans shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a low noise fan blade.

D. Low speed fan motors shall be three-phase with permanently lubricated ball bearings and individually protected by circuit breakers.

E. Unit shall be capable of starting and running at outdoor ambient temperatures from 32F to 125F (0C to 52C).

F. Provide coil protection for shipping. Entire condenser coil shall be covered with heavy plastic to prevent inadvertent damage to coil during shipment or rigging.

2.7 ENCLOSURES

A. Mount starters in a UL1995 rated panel for outdoor use.

B. The starter shall be across-the-line configuration, factory-mounted and fully pre-wired to the compressor motor(s) and control panel.

C. Unit shall have a single point power connection.

D. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

E. Control panel shall be dead front construction for enhanced service technician safety.

F. Power line connection type shall be standard with a terminal block.

2.8 REFRIGERATION COMPONENTS

A. Each refrigerant circuit shall include a filter drier, electronic expansion valve with site glass, liquid line service valves and a complete operating charge of both refrigerant HFC-410A and compressor oil.

B. Each refrigerant circuit shall include a discharge line service valve to allow the refrigerant to be isolated in the condenser.

2.9 CONTROLS, SAFETIES AND DIAGNOSTICS

A. The microprocessor-based unit controller shall be factory-installed and factory-tested.

B. Include Bacnet Gateway to communicate with the existing Johnson Controls Metasys ATC system.

C. The unit display shall provide the following data:

1. Water and air temperatures

2. Refrigerant levels and temperatures

3. Flow switch status

4. Compressor starts and run times

D. The unit controller shall provide chilled water reset based on return water as an energy saving option.

E. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. Controls shall include the following readouts and diagnostics:

1. Low evaporator refrigerant temperature and/or pressure

2. High condenser refrigerant pressure

3. Motor current overload

4. High compressor discharge temperature

5. Electronic distribution faults: phase loss, phase imbalance, or phase reversal

F. Unit shall be shipped with factory control and power wiring installed.

G. On chiller, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer and a single 115 volt 60 Hz single phase connection for evaporator freeze protection heaters.

H. Provide single 115 volt 60 Hz single phase connection for evaporator freeze protection heaters.

I. The unit controller shall utilize a microprocessor that will automatically take action to prevent unit shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.

J. Provide the following safety controls with indicating lights or diagnostic readouts.

1. Low chilled water temperature protection.

2. High refrigerant pressure.

3. Low oil flow protection.

4. Loss of chilled water flow.

5. Contact for remote emergency shutdown.

6. Motor current overload.

7. Phase reversal/unbalance/single phasing.

8. Over/under voltage.

9. Failure of water temperature sensor used by controller.

10. Compressor status (on or off).

K. Provide the following operating controls:

1. Chilled water pump output relay that closes when the chiller is given a signal to start.

2. High ambient pressure controller that shuts off a compressor to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.

3. Compressor current sensing limit that shuts off a compressor to help prevent current overload nuisance trips.

4. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor cannot provide this function then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.

5. Low ambient lockout control with adjustable setpoint.

L. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:

1. Leaving chilled water setpoint adjustment from LCD input

2. Entering and leaving chilled water temperature output

3. Percent RLA output for each compressor

4. Pressure output of condenser for circuits one and two

5. Pressure output of evaporator for circuits one and two

6. Ambient temperature output

7. Voltage output

8. Current limit setpoint adjustment from LCD input.

2.10 CHILLED FLUID CIRCUIT

A. Chilled fluid circuit shall be rated for 150 psig (1034 kPa) working pressure.

B. Proof of flow switch shall be provided by the equipment manufacturer and installed the correct number of pipe diameters from any elbow and in the correct orientation.

C. Flow switch shall be IFM flow monitor type.

D. Units with brazed plate evaporators shall have a 16 mesh water strainer that is factory provided. It shall be installed with a blowdown valve to facilitate periodic cleaning of the strainer to prevent it from becoming clogged.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Align chiller package on steel or concrete foundations.

C. Install units on isolators.

D. Connect to electrical service.

E. Connect to chilled water piping.

3.2 SCHEDULE

3.3 MANUFACTURER'S FIELD SERVICES

A. OEM Startup is performed by factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.

1. Included OEM Factory Startup:

a. Centrifugal, Rotary Screw, and Scroll Chillers

B. Applied Chiller manufacturers shall maintain service capabilities no more than 150 miles from the jobsite.

C. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

END OF SECTION 23 6210

END OF DIVISION 23