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", and "2015 International Fire Code" as published by the International Conference of Building Officials.
4. “2015 Idaho Plumbing Code.” as published by the International Association of Plumbing and Mechanical Officials.
5. "National Electrical Code" as published by the National Fire Protection Association.
6. "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 230501

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. Heat Pump, Cooling Tower, Gas, & 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
LPG	Propane Gas	Yellow
FS	Fire Sprinkler	Red
HPS	Heat Pump Supply	Green
HPR	Heat Pump Return	Green
CTS	Cooling Tower Supply	Blue
CTR	Cooling Tower Return	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 230553

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. Heat Pumps.
      b. Exhaust Fans.
      c. Kitchen Hood System
   2. Hydronic Piping Systems.
      a. Primary - Secondary Systems
      b. Cooling Tower
      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 KITCHEN HOOD

A. A Performance test shall be conducted upon completion, and before final approval of the installation of a ventilation system serving commercial cooking appliances. The test shall verify the rate of exhaust airflow of the capacity of the hood, make-up airflow required and proper operation. This test will be required to be provided to the HVAC Inspector prior to final inspection.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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 230593

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. Ductwork Insulation
   2. Heat Pump Piping Insulation
   3. Boilers, Tanks, Headers, and Breechings
   4. Refrigerant Piping
   5. 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 230712

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.

C. Hot:
   1. On fittings where temperature exceeds 250 degrees F., two layers of factory precut Hi-Lo Temp insulation inserts shall be applied with a few wrappings of twine on first layer, to be sure there are no voids or hot spots. Fitting cover shall then be applied over Hi-Lo Temp insulation as described above in "A."

END OF SECTION 230714

SECTION 23 0715 – HEAT PUMP 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. 6 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 230715

SECTION 23 0716 - DUCTWORK INSULATION

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 insulation on air ducts outside building insulation envelope as described in Contract Documents.

B. Furnish and install insulation on fresh air ducts and combustion air ducts within building insulation envelope as described in Contract Documents.

C. Furnish and install insulation on other air ducts where indicated on Drawings.

PART 2 - PRODUCTS

2.1 INSULATION

A. 1-1/2 inch thick fiberglass with aluminum foil scrim kraft facing and have a density of one lb/cu ft.

B. Approved Manufacturers:
   1. Manville Microlite FSK
   2. CSG Type IV standard duct insulation
   3. Owens-Corning FRK
   4. Knauf (Duct Wrap FSK)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct wrap in accordance with Manufacturer's recommendations.

B. Do not compress insulation except in areas of structural interference.

C. Completely seal joints.

END OF SECTION 230716

SECTION 23 0717 – ROUND SUPPLY DUCT 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 round supply duct insulation as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Insulation shall be UL rated with FSK (foil-skrim-kraft) facing.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Fiberglass blanket insulation

B. Approved Manufacturers:
   1. Johns-Manville R-4 Microlite (R-4 does not include the vapor barrier material).
   2. Owens-Corning faced duct wrap insulation FRK-25 ED-150
   3. Certainteed Standard Duct Wrap.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Insulate round air supply ducts.

B. Facing shall overlap 2" at joints and shall be secured with outward clinch staples on 4" centers.

C. Ducts over 30" in width shall have spot application of adhesive, weld pins or metal screws and caps on not more than 18" centers applied to underside.

D. 3" wide vapor barrier paper shall be applied over seams and sealed with vapor barrier adhesive.

E. Insulate attenuators.

F. Insulate high and low pressure flex ducts.

END OF SECTION 230717

SECTION 23 0718 - DUCT LINING

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 acoustic lining in following above ground metal ductwork as described in Contract Documents unless detailed otherwise:
   1. Outside air
   2. Supply air
   3. Return air
   4. Mixed air
   5. Transfer air
   6. Relief air
   7. Elbows, fittings, and diffuser drops greater than 12 inches in length.

1.3 SYSTEM DESCRIPTION

A. Duct dimensions shown on Drawings are for free area inside insulation. Allowance must be made for insulation, where applicable.

1.4 RATINGS:

A. Material shall have maximum air friction correction factor of 1.10 at 1000 FPM velocity and have a minimum sound absorption coefficient NRC of .60.

PART 2 - PRODUCTS

2.1 DUCT LINER

A. One inch thick, 1-1/2 lb density fiberglass, factory edge coated.

B. Duct lining materials are to meet the requirements of UL 181 for mold, humidity, and erosion resistance.

C. Approved Manufacturers:
   1. Certainteed Ultralite 150 Certa Edge Coat
   2. Knauf - Type M
   3. Manville - Lina-Coustic
   4. Owen Corning Fiberglas - Aeroflex

2.2 ADHESIVE

A. Water Base Type:
   1. Cain - Hydrotak
   2. Duro Dyne - WSA
   3. Kingco - 10-568
   4. Miracle - PF-101
   5. Mon-Eco - 22-67
   6. Techno Adhesive - 133

B. Solvent Base (non-flammable) Type:
   1. Cain - Safetak
   2. Duro Dyne - FPG
   3. Kingco - 15-137
   4. Miracle - PF-91
   5. Mon-Eco - 22-24
   6. Techno Adhesive - 'Non-Flam' 106

C. Solvent Base (flammable) Type:
   1. Cain - HV200
   2. Duro Dyne - MPG
   3. Kingco - 15-146
   4. Miracle - PF-96
   5. Mon-Eco - 22-22
   6. Techno Adhesive - 'Flammable' 106

2.3 FASTENERS

A. Adhesively secured fasteners not allowed.

B. Approved Manufacturers:
   1. AGM Industries Inc - "DynaPoint" Series DD-9 pin
   2. Cain
   3. Duro Dyne
   4. Omark dished head "Insul-Pins"
   5. Grip nails may be used if each nail is installed by "Grip Nail Air Hammer" or by "Automatic Fastener Equipment" in accordance with Manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous 100% coat of adhesive and with 3/4 inch long mechanical fasteners 12 inches on center maximum unless detailed otherwise on Drawings. Pin all duct liner.

B. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom sections of insulation shall overlap sides. If liner is all one piece, folded corners shall be tight against metal. Ends shall butt tightly together.

C. In casings and plenums further contain insulation with wire mesh.

3.2 FIELD QUALITY CONTROL

A. If insulation is installed without longitudinal and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.

B. Insulation shall be installed in accordance with Duct Liner Application Standard SMACNA Manual 15.

3.3 ADJUSTING, CLEANING

A. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty.

END OF SECTION 230718

SECTION 23 0722 – FIRE PROTECTION DUCT WRAP

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 grease and air ducts requiring UL and NFPA fire protection within confines of building as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Composition & Materials:
   1. The PYROSCAT FP Duct Wrap system is composed of two layers of 1 ½" thick refractory grade fibrous fire barrier material designed to withstand temperatures in excess of 2000℉. The PYROSCAT FP Duct Wrap comes in three forms, aluminum foil laminated on both sides, aluminum foil laminated on one side, and no foil lamination. When the system is used in floor or wall penetrations, the PYROSCAT FP Duct Wrap is used in conjunction with Nelson FSP Fire Stop Putty.

B. Applicable Standards and Codes
   1. PYROSCAT FP Duct Wrap meets the requirements of UL YYET for Grease Duct Enclosures in accordance with SBCCI Acceptance Criteria. This standard requires that the system meet the following:1)an external full scale fire test for 1 and/or 2 Hr Fire Resistance duct enclosures and through penetrations per UL 263/ASTM E-119 with hose stream; 2) minimum temperature rise standards in the 2000℉ Abnormal Temperature Test as detailed in "UL Subject 1978 Proposed First Edition of the Standard for Grease Ducts", 3) Surface Burning Characteristics per UL 723 (ASTM E-84 with FSI not over 25 and SDI not over 50. All testing for acceptance has been conducted at Underwriters Laboratories located in Northbrook, IL.
   2. PYROSCAT FP Duct Wrap also meets all applicable requirements of NFPA 96 "Standard for Vent. Control and Fire Protection of Commercial Cooking Operations".
   3. Duct wrap shall be listed to AC-100/ASTM 2336 test standard for grease duct wrap. Also duct wrap shall comply with latest ICC Evaluation Services Report and 2015 IMC.

2.2 MANUFACTURER

A. PYROSCAT FP Duct Wrap by Premier Refractories.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prior to use or concealment of any portion of the grease duct system, a leakage test shall be performed. This test will be required to be provided to the HVAC Inspector prior to concealment of the Grease Duct.

B. PYROSCAT FP Duct Wrap shall be applied by qualified contractors. The fire barrier material is supplied in roll form 24" x 300", or 48" x 180". Two layers are required to meet UL YYET for Grease Duct Enclosures and 2 Hr Fire Rated Air Duct Enclosures. Layers are overlapped a minimum of 3" and are secured using insulation pins, aluminum foil tape, and banding. See Guide to Installation of PYROSCAT FP Duct Wrap for Grease and Air Ducts.

END OF SECTION 230722

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 230800

SECTION 23 0900 – BUILDING AUTOMATION CONTROL SYSTEM (Base Bid)

PART 1 - SYSTEM OVERVIEW

1.1 DDC CONTROL SYSTEM

A. Statement of Intent

1. The intent of this specification is to provide a high-quality Direct Digital Control system with Web based software front end and top-of-the-line control hardware. System is to include a Graphical User Interface (GUI) residing on a WebServer accessible with an industry standard non-proprietary Web Browser. Connectivity shall be over the owner's internal Ethernet system and, when allowed, over the Internet using the servers IP address. Connection to the WebServer software shall be thin client access and shall not require that the browser device have special software or applets for access. If connection to an Intranet or to the Internet is not available on initial installation, the server shall be accessed via a web browser locally hosted on the server. The graphic user interface shall display real time values of all system operating conditions. Additionally, it shall include graphic displays of system programming, operating logic and logic flow. It shall display logic flow with real time values of logical inputs and outputs. This graphical display capability is required for system diagnostics of both the mechanical systems controlled by the DDC system and of the operating logic and sequences themselves. The features of the system must be fully installed, configured and demonstrated in a manner that provides maximum benefit to the end user.

B. Specification Compliance

1. These specifications are intended to provide 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.

C. Approved DDC Contractor and System

1. DDC Control System shall be:
   a. Automated Logic WebCTRL by Clima-Tech Corporation
   b. No Substitute

2. Contractors wishing to provide pricing for this project shall submit request to project Engineers not later than 10 working days prior to bid opening date. This is to allow for system demonstration for owner and design team prior to bid date.

1.2 SCOPE OF WORK

A. Refer to the matrix at the end of this specification that shows the scope of responsibility for the various trades:

1 Control Hardware and Software

a. The Automatic Temperature Control (ATC) Contractor shall be responsible for furnishing and installing all control hardware and software necessary for a 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, except those valves, dampers and actuators specified to be furnished by equipment supplier. When actuators are specified to be furnished by equipment supplier, that supplier shall be responsible for coordination of actuator control input for interface with DDC system without use of transducers. Automatic control valves, dry wells for fluid temperature sensors, dampers and actuators shall be installed by the mechanical contractor.

2. Specifically the ATC Contractor shall furnish the following:

a Individual unitary control modules for each unitary system:

1. Water to Air Heat Pumps
2. Package Rooftop Units

b Individual control modules for all non-unitary air handlers or package units:

1. Gas Fired Makeup Air Unit
2. Energy Recovery Unit

c General purpose modules for control of central fan, pump, chiller, boiler or tower operation:

1. Boiler System
2. Cooling Tower
3. HP Circulation System

d Required peripheral mechanical components to be furnished by ATC contractor:

1. Heat Pump Isolation Valve and Actuator

e Required non-HVAC controls to be furnished by ATC contractor:

1. None

f Required software integration to other digital control systems:

1. None

3. Control Wiring and Interface to Line Voltage Control

a. ATC Contractor shall be responsible for control wiring to all control modules, sensors, pilot duty control relays and actuators required to provide Sequences of Operation as noted in Part 5. ATC contractor shall provide control interface to boilers, chillers, pumps and fans. This shall include pilot duty relays where interface to line voltage switching devices is required. ATC Contractor shall provide all required conduit for low voltage wiring within mechanical rooms or at equipment locations unless specifically shown on Division 16 drawings. Electrical Contractor shall provide all required conduit for line voltage wiring, all contactors, magnetic starters and motor control centers required for operation of mechanical systems except where specifically noted to be provided by equipment manufacturer. Electrical contractor shall furnish conduit where required between the zone temperature sensor locations and the zone equipment. The Electrical Contractor shall also be responsible for line voltage circuits and connection to ATC panels.

b. Unitary equipment will be supplied with required fan relays, compressor contactors, electric heat sequencers and transformer ready for connection to ATC provided control modules.

4. Control Integration with Third Party Digital Controls Supplied by Others

a. Automatic Temperature Control (ATC) Contractor shall be responsible for all programming of controls furnished by them to accomplish the required integration. ATC Contractor shall provide necessary hardware to maintain these programs. Local area network wiring required for connection to interface hardware provided under the ATC project scope is the responsibility of the ATC Contractor. If Ethernet connection to third party controls is required, that network connection shall be the responsibility of others.

b. Suppliers of equipment that is required to be integrated with the DDC system shall be responsible to coordinate integration software protocol and connectivity with ATC Contractor prior to bid to insure satisfactory integration and system operation. Equipment suppliers are required to confirm that their factory installed controls are capable of achieving sequences of operation listed under this section, and that required points are available to the DDC system. If specified sequences cannot be met with factory installed controls the equipment supplier shall be responsible for furnishing and installing required external controls or peripheral devices. Any required communication wiring between digital control devices provided by equipment suppliers shall be the responsibility of that supplier. This may be under separate agreement with the ATC Contractor.

c. Equipment suppliers shall provide complete points list including Usage Description, Addresses and Device ID numbers, and network number if applicable.

d. Acceptable protocols:
1. Variable Frequency Drives, lighting systems or power monitoring systems shall use either Modbus or BACnet software protocols for integration to this DDC system.

5. Commissioning

a. ATC Contractor shall be responsible for self-commissioning of all hardware and software programming furnished with the project. Completed point checkout commissioning sheets shall be included with the final "as-built" O&M manuals. These sheets shall include validation check fields for each physical and software or network input and output, with date and time of verification and initials of individual preforming the checkout. Physical point checkout lists shall include check offs for point type, address, scaling range, and any calibration offset. Software point checkout lists shall include check offs for mapped address and communication verification. Point checkout lists shall use logical names for future reference by the owner.

b. Each graphic file will be checked for visual accuracy and to verify that point mapping on those files is correct. Each unique operating program shall be functionally tested to confirm that operation conforms to the Sequence of Operation. Documentation of graphic commissioning and Functional Performance Testing shall be included in the project O&M manuals.

6. Training and Technical Support

a. Contractor shall provide 8 hours of factory approved classroom training for owner representatives on operation and servicing of the automatic temperature control system. Training shall be oriented to make 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 for 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.

b. Classes shall be given at a location remote from the student's place of work to minimize distractions. Classes shall be scheduled multiple times during the first year to allow flexibility for Owner's representative to attend. Tuition to these classes shall be included within the scope of this project. If course locations are more than 200 miles from the project site, cost of transportation, lodging and meals shall be included within the scope of this project.

c. The contractor shall provide unlimited phone technical support to the owner's 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.

PART 2 - SUBMITTALS AND O&M MANUALS

2.1 SUBMITTALS

A. Submittals shall include the following sections:

1. Shop Drawings with:

a. Title Page
b. Table of Contents
c. Typical Device Wiring Drawings
d. Summary Bill of Materials
e. Sequences of Operation
f. Local Area Network Drawings
g. Drawings for all operating systems showing both equipment and module connections
h. Bill of Materials Specific to Each Drawing

2. Manufacturer's specification data sheets for all:

a. Control Modules
b. Sensors
c. Dampers
e. Valves
f. Actuators
g. Flow switches
h. Current sensors
i. Transducers

B. 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.

C. 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.

2.2 SYSTEM SOFTWARE

A. System Software shall include the following:
   1. DDC operating system
   2. Any software required for control logic programming
   3. Any software required for graphics generation
   4. Any other software used to create a fully functional system
   5. Site specific database

B. All software programs shall be installed on the owner's server.

C. All licenses shall become the property of the Owner

PART 3 - CONTRACTOR CAPABILITY

A. Contractor shall maintain toll-free technical support phone line or accept collect phone calls during warranty period.

B. Contractor shall provide service within 24 hours.

C. Contractor service and installation technicians shall be technically proficient in both control systems and mechanical service.

PART 4 - HARDWARE

4.1 SYSTEM SERVER

Merge new equipment into existing Automated Logic frontend server

4.2 FIELD HARDWARE

4.3 BACnet

A. 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):

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

B. Distributed Control

1. 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.

C. Ethernet Gateway Routers

1. 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 the customer's Ethernet the gateway shall be capable of connection via a web browser on the local host server.

D. Control Modules

1. 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.

2. Modules shall be fully programmable for maximum system flexibility. Application specific controllers are not acceptable.

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

4. 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.

5. Control Modules shall communicate via BACnet over either:

   a. ARCnet at a speed of 156 kbaud

E. Temperature Sensors (analog)

1. Wall mounted zone temperature sensors shall be 10 k ohm thermistor.

2. 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 the setpoint within operator defined parameters. 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.

3. 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.

4. Gymnasium sensors shall also include a key access override feature.

2. All other temperature sensors shall be industry standard thermistor or 4-20 milli-amp.

3. Minimum of two outside air sensors are required for each facility and software programmed to use the lower temperature of the two for any control logic that uses OAT.

4. Immersion sensors shall be mounted in a blind well for future serviceability.

F. AHU Freeze Protection Thermostats (binary)

1. All Air Handling Units with outside air and Heating Water, Chilled Water, Condenser Water or Steam coils shall have a manual reset binary freeze protection thermostat installed downstream of each coil. Exceptions shall be made when water circuits are protected with glycol.

2. Freeze protection thermostats shall be wired to directly open the control circuits for the fans. Control module outputs for freeze protection shall only be used for redundancy.

3. An auxiliary switch on the freeze protection shall be wired to the AHU control module for alarming and additional control actions.

G. Current Transformers

1. Current transformers used for fan status on belt drive constant volume air handlers shall be adjustable type. These shall be calibrated to indicate fan failure on belt loss.

2. Current transformers used for pump status on pumps larger than 1 horsepower shall be adjustable type. These shall be calibrated to indicate pump failure when the pump cavitates on flow loss.

3. Current transformers used for fan status on variable frequency drives shall be analog type. Software should note max flow amperage. Equipment program will indicate fan loss if amp draw drops below 60% of max flow amperage and software requests drive speed above 50 hz.

H. Pressure Sensors (analog)

1. Duct pressure sensors used for control of variable air flow air handling units shall be located in the longest duct run approximately 2/3 of the total duct length from the AHU.

2. Building pressure sensors used for control of outside or relief air shall have more than one OA pressure reference point to minimize wind effects. OA pressure pickup shall be protected against blockage by insects.

3. Hydronic pressure sensors used for control of variable flow pumps shall be located across a unit without a two way valve and pressure differential set 1.5 times the design pressure drop across that unit.

I. Hi Pressure Safety (binary)

1. Variable air flow air handling units shall have a manual high static pressure safety located at the AHU outlet to provide safety shut down if pressure exceeds 5" for more than 30 seconds. Variable frequency drives should be programmed for soft start to prevent nuisance tripping on startup.

J. Valve and Damper Actuators

1. Actuators shall be manufactured by Belimo.

2. Torque shall be rated 20% above required load.

3. 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, multi-zone dampers, valves or any other application where modulated operation is specified.

4. Damper actuators used on any damper where one side is exposed to outside air shall have spring return to close dampers upon loss of power.

5. Valve actuators used on any Heating Water Valve shall have spring return to open valve upon loss of power.

6. Valve actuators used on any Steam Valve shall have spring return to close valve on loss of power.

K. Dampers

1. Any damper where one side is exposed to outside air 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. Exception will be combustion intake dampers and air to air heat exchange relief dampers.

2. When outside air intake dampers for economizers are furnished by ATC Contractor those dampers shall be opposed blade style.

3. Individual damper blades shall not exceed 48”.

L. Wire

1. All wiring in open areas at heights below 12 feet must be run in conduit.

2. Control wiring may be run open in accessible ceiling or under floor areas.

3. Control wiring in non-accessible ceilings, walls or floors shall be in conduit.

4. All wiring not in conduit or control cabinets shall be rated for plenum installation.

5. Communication wiring shall be run in data cable tray whenever possible.

PART 5 - SOFTWARE

A. 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.

B MULTI-BROWSER ACCESS

1. Internet, Intranet or Local Host access to the system shall be via thin client browser access using any standard browser, such as Internet Explorer, Firefox or Chrome

C GRAPHICAL PROGRAMMING

1. The system shall be programmed using a graphical programming language for ease of operator understanding. Operating sequences and logic flow shall be assembled in a schematic format using visually descriptive micro-blocks or icons representing inputs, outputs and logical functions such as and/or logic, 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.

D GRAPHICAL INTERFACE SOFTWARE

1 System and Equipment Graphics

a. The operator’s interface software shall be graphics based and display in 256 colors at a minimum 1024 x 768 pixel resolution. 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.

b. 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.

c. 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.

2 Graphical Screen Replay

a. The system shall have the ability to replay up to 24 hours of thermal graphic floorplans, equipment graphics, alarms or trend pages, starting at a specified date and time as a troubleshooting tool.

3 Software Graphic Programming Live User Interface

a. 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 mirco-block in the graphical program to change parameters including the ability to lock values.

E. FACILITY MANAGEMENT AND ENERGY MANAGEMENT FUNCTIONS

1. Scheduling

a. For maximum flexibility, schedules shall reside in the local control modules. Systems that rely on Central Control Modules for scheduling are not acceptable.

b. Schedules shall be at the zone level. Central plant or fan operations shall not be scheduled, rather they shall run based on requests from the zones that they serve.

c. 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.

d. Available schedule types shall include normal operation, unoccupied operation, setback override and holidays.

e. Dated schedules shall be self managing and automatically delete after execution.

2. Demand Control

a. The system shall have the ability to receive an analog or digital input of electrical usage/demand through any open input on a general purpose module. If demand control is implemented in the future, this capability shall not require any additional DDC hardware except the single input point and, when implemented, the digital or analog devices required to read electrical demand levels.

b. The system shall be capable of rotating greater or lower demand levels every 10 minutes to alternate zones throughout the facility to minimize long term setpoint offset.

3. Interactive Operations

a. 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.

4. Enterprise Integration

a. The system shall be capable of exchanging web services (via XML/SOAP) information with other Enterprise servers for the purpose of optimizing system operation, e.g. obtaining NOAA Weather

Service for optimizing night purge operation, or for the purpose of providing information to other Enterprise servers to optimize other building information systems, e.g. providing maintenance notifications to an Enterprise based facilities maintenance software.

b. The software to enable this interface shall be provided and fully operational within the scope of this project.

5. Environmental Index.

a. System shall monitor all occupied zones and compile an index that provides a numerical indication of the environmental comfort within the zone. As a minimum, this indication shall be based upon the deviation of the zone temperature from the heating or cooling setpoint. If humidity is being measured within the zone then the environmental index shall be adjusted to reflect a lower comfort level for high or low humidity levels. Similarly, if carbon dioxide levels are being measured as an indication of ventilation effectiveness then the environmental index shall be adjusted to indicate degraded comfort at high carbon dioxide levels. Other adjustments may be made to the environmental index based upon additional measurements. The system shall maintain a trend of the environmental index for each zone in the trend log. The system shall also compute an average comfort index for every building included in this contract and maintain trend logs of these building environmental indices. Similarly, the system shall compute the percentage of occupied time that comfortable conditions were maintained within the zones. Through the UI the user shall be able to add a weighting factor to adjust the contribution of each zone to the average index based upon the floor area of the zone, importance of the zone, or other static criteria.

F. ALARMS, TRENDS AND REPORTS

1. System and Temperature Alarms

a. The system shall have the capability of monitoring conditions throughout the system and sending alarms via text 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

a. The system shall be capable of trending any input or output, or any logical point within an operating program, e.g. output of a PID. 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

a. 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 6 - SEQUENCES OF OPERATION

A. GENERAL

1. The following sequences of operation shall be strictly observed. All temperature setpoints, static pressure setpoints, percentage of PID output trip points and reset ratios within this specification shall be changeable by operator using the operator software furnished with the system.

B. DISTRIBUTED CONTROL

1. System shall observe the concept of distributed control. 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.

C. CENTRAL PLANT, PUMP AND FAN OPERATION

1. Control of all central fan systems, chillers, boilers and pumping stations shall be based on run requests, heating requests or cooling requests from zone controls. Reset of supply air static pressure, supply air temperature, chilled water temperature and hot water temperature shall be based on zone temperature conditions and heating or cooling requests from zones.

D. SCHEDULING

1. For maximum flexibility all occupancy schedules shall be stored in zone control modules. Central fans or pumps shall start when commanded from any associated zones that call for occupancy or for operation to meet setback heating or cooling requirements and shall not require separate scheduling unless required for the sequence of operation. Fans or pumps larger than 5 horsepower shall run for minimum of 30 minutes.

END OF SECTION 230900

SECTION 23 0950 – BUILDING AUTOMATION CONTROL SYSTEM (ALTERNATE BID)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management system (FMCS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.

B. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

C. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

D. Qualifications:
   1. Installer:
      a. Before bidding, obtain sponsorship from a local, Approved Distributor specified under PART 2 PRODUCTS. Initial requirements for sponsorship are:
         1) Be one of following Honeywell supported partners:
            a) Honeywell-Automation Control Specialist (ACS).
            b) Honeywell Authorized Control Integrator (ACI).
         2) Receive product training from and exhibit LCBS system skills to sponsoring Approved Distributor.

1.2 SYSTEM DESCRIPTION

A. The entire Temperature Control System (TCS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating via LonMark™/LonTalk™ communication prools to a Network Area Controller (NAC). Temperature Control System products shall be by approved manufacturers.

B. The Temperature Control Systems (TCS) consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and perform functions specified.

C. The Facility Management and Control System (FMCS) shall be comprised of Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to LonMark™/LonTalk™ (IDC) controllers and other open prool systems/devices provided.

D. The Facility Management and Control System (FMCS) as provided in this Division shall be based on a hierarchical architecture incorporating the Niagara AX Framework™. Systems not developed on the Niagara AX Framework™ platform are unacceptable.

E. The Facility Management and Control System (FMCS) shall monitor and control equipment as called for by the "Sequence of Operation" and points list.

F. The Facility Management and Control System (FMCS) shall provide full graphic software capable of complete system operation.

G. The Facility Management and Control System (FMCS) shall provide full graphic operator interface to include the following graphics as a minimum:
   1. Home page to include a minimum of six critical points.
   2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
   3. Detail graphics for each mechanical system to include; AHUs (Air Handling Units), VAV (Variable Air Volume Units), EFs (Exhaust Fans), Pumps, Chillers, and Boilers as a minimum.
   4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.

H. The FMCS shall provide automated alarming software capable of sending messages to email compatible cellular telephones via the owner's e-mail service. The email alarm paging system shall be able to segregate users, time schedules, and equipment, and be capable of being programmed by the owner.

I. It is preferable that any dedicated configuration tool required for controller configuration have the capability to be launched from within the applicable Network Management Software. If the configuration tool(s) cannot be launched from the Network Management Software, any software required for controller configuration shall be included as a leave-behind tool with enough license capability to support the installation.

J. The contractor shall provide the appropriate quantity of legal copies of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be generally available in the market. No closed and/or unavailable tools will be permitted. Contractor shall convey all software tools and their legal licenses at project close out.

1.3 SUBMITTAL

A. See Section 01 3300 – for submittal procedures.

B. Shop drawings of the components and devices for the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions for all controllers, valves, dampers, sensors, routers, etc. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package.

1. Damper Schedule: Damper and actuator sizing shall be performed, and a schedule created by the manufacturer. The schedule shall include a separate line for each damper and a column for each of the damper attributes: Damper Identification Tag, Location, Damper Type, Damper Size, Duct Size, Arrangement, Blade Type, Velocity, Pressure Drop, Fail Position, Actuator Identification Tag, Actuator Type, and Mounting.
2. Valve Schedule: Valve sizing shall be performed, and a schedule created by the valve manufacturer. The schedule shall include a separate line for each valve and a column for each of the valve attributes: Valve Identification Tag, Location, Valve Type, Valve Size, Pipe Size, Configuration, Flow Characteristics, Capacity, Valve CV, Calculated CV, Design Pressure Drop, Actual Pressure Drop, Fail Position, Close off Pressure, Actuator Identification Tag, and Actuator Type.

C. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media, and prool. Though the Section 23 and Section 26 contractors shall provide these diagrams for their portions of work, the Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN) and/or Local Area Network (LAN) utilized by the FMCS.

1. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system expansion with minimal infrastructure modifications.

D. Submittal shall also include a complete point list of all points to be connected to the TCS and FMCS.

E. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk. Drawings shall be provided as AuAD™ compatible files.

1.4 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

1. DDC - Direct Digital Controls
2. FMCS - Facility Management and Control System
3. GUI - Graphical User Interface
4. IDC - Interoperable Digital Controller
5. LAN - Local Area Network
6. NAC - Network Area Controller
7. OOT - Object Oriented Technology
8. PICS - Product Interoperability Compliance Statement
9. PMI - Power Measurement Interface
10. POT - Portable Operator's Terminal
11. TCS - Temperature Control System
12. WAN - Wide Area Network
13. WBI - Web Browser Interface

1.5 SOFTWARE LICENSE AGREEMENT

A. The Owner shall agree to the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

B. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS, and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

1.6 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.

C. Distributors:
   1. Obtain LonSpec database, panels, controllers, sensors, valves, dampers, and other control equipment from one of the following Sponsoring Approved Distributors.
      a. Control Equipment Co: (800) 452-1457. rhowe@controlequiputah.com Ray Howe
      b. Control Solutions & Design: (208) 375-4422. pdl@csdidaho.com Paul Lachowsky
      c. RSD Total Control: (800) 245-8007, ext 255. jransford@rsd.net Joe Ransford
      d. Sabol & Rice Inc: (801) 978-4208. ray@sabolrice.com Ray Howe
      e. Honeywell: (801) 978-7137. chris.brinkerhoff@honeywell.com Chris Brinkerhoff.

2.2 ACCEPTABLE MANUFACTURERS

A. Basis-of-Design: Honeywell WEBs-AX™. Subject to compliance with requirements.
   1. Honeywell: As an extension to the existing Honeywell control system used by the School District.

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate LonWorks™ technology.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-2001, LonMark to assure interoperability between all system components is required. Each LonWorks device must have LonMark certification.

C. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
   1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for local network connected user interfaces.
   2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.4 NETWORKS

A. The Local Area Network (LAN) shall be a 100 Megabit/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:
   1. Ethernet; IEEE standard 802.3
   2. Cable; 100 Base-T, UTP-8 wire, category 5
   3. Minimum throughput; 100 Mbps.

2.5 NETWORK ACCESS

A. Remote Access.
   1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access. Owner agrees to pay any monthly access charges for connection and ISP.

2.6 NETWORK AREA CONTROLLER (NAC)

A. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
   1. Calendar functions.
   2. Scheduling.
   3. Trending.
   4. Alarm monitoring and routing.

5. Time synchronization.
6. Integration of LonWorks controller data.
7. Network Management functions for all LonWorks based devices.

B. The Network Area Controller shall provide the following hardware features as a minimum:
1. One Ethernet Port – 10/100 Mbps.
2. One RS-232 port.
3. One LonWorks Interface Port – 78KB FTT-10A.
4. Battery Backup.
5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity).
6. The NAC must be capable of operation over a temperature range of 32 to 122°F.
7. The NAC must be capable of withstanding storage temperatures of between 0 and 158°F.
8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.

C. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

D. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.

E. Event Alarm Notification and actions
1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network, or remote via dial-up telephone connection or wide-area network.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
   a. In alarm
   b. Return to normal
   c. Fault condition
4. Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and/or classes of alarms, i.e.: security, HVAC, Fire, etc.
5. Provide timed (schedule) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

F. Controller and network failures shall be treated as alarms and annunciated.

G. Alarms shall be annunciated in any of the following manners as defined by the user:
1. Screen message text.
2. Email of the complete alarm message to multiple recipients via the owner's e-mail service. Provide the ability to route and email alarms based on:
   a. Day of week.
   b. Time of day.
   c. Recipient.
3. Graphic with flashing alarm object(s).
4. Printed message, routed directly to a dedicated alarm printer.

H. The following shall be recorded by the NAC for each alarm (at a minimum):
1. Time and date.
2. Location (building, floor, zone, office number, etc.).
3. Equipment (air handler #, access way, etc.).
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

I. Alarm actions may be initiated by user defined programmable objects created for that purpose.

J. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

2.7 DATA COLLECTION AND STORAGE

A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.

B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
1. Designating the log as interval or deviation.

2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

2.8 AUDIT LOG

A. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
1. Time and date
2. User ID
3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.9 ADVANCED UNITARY CONTROLLER

A. The controller platform shall be designed specifically to control HVAC – ventilation, filtration, heating, cooling, humidification, and distribution. Equipment includes: constant volume air handlers, VAV air handlers, packaged RTU, heat pumps, unit vents, fan coils, natural convection units, and radiant panels. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the "Sequence of Operation" as outlined.

B. Minimum Requirements:
1. The controller shall be capable of either integrating with other devices or stand-alone operation.
2. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for LonWorks™ network communications.
   a. FLASH Memory Capacity: 116 Kilobytes with 8 Kilobytes for application program.
   b. FLASH Memory settings retained for ten years.
   c. RAM: 8 Kilobytes
3. The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.
4. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
   a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
   b. Accuracy: ±1 minute per month at 77° F (25° C).
   c. Power Failure Backup: 24 hours at 32° to 100° F (0° to 38° C), 22 hours at 100° to 122° F (38° to 50° C).
5. The controller shall include Sylk Bus, a two wire, polarity insensitive bus that provides both 18 Vdc power and communications between a Sylk-enabled device and a Sylk-enabled controller.
6. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
7. The controller shall have an internal DC power supply to power external sensors.
   a. Power Output: 20 VDC ±10% at 75 mA.
8. The controller shall have a visual indication (LED) of the status of the devise:
   a. Controller operating normally.
   b. Controller in process of download.
   c. Controller in manual mode under control of software tool.
   d. Controller lost its configuration.
   e. No power to controller, low voltage, or controller damage.
   f. Processor and/or controller are not operating.
9. The minimum controller Environmental ratings
   a. Operating Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
   b. Storage Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
   c. Relative Humidity: 5% to 95% non-condensing.
10. The controller shall have the additional approval requirements, listings, and approvals:
   a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
   b. CSA (LR95329-3) Listed
   c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
   d. Meets Canadian standard C108.8 (radiated emissions).

e. Conforms to the following requirements per European Consortium standards:
f. EN 61000-6-1; 2001 (EU Immunity)
g. EN 61000-6-3; 2001 (EU Emissions)

11. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
12. The controller shall have sufficient on-board inputs and outputs to support the application.
    a. Analog outputs (AO) shall be capable of being configured to support 0-10 V, 2-10 V or 4-20 mA devices.
    b. Triac outputs shall be capable of switching 30 Volts at 500 mA.
    c. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring. Input and Output wiring terminals shall be designated with color coded labels.
    d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).
13. The controller shall provide for "user defined" Network Variables (NV) for customized configurations and naming using Niagara AX Framework™.
    a. The controller shall support 240 Network Variables with a byte count of 31 per variable.
    b. The controller shall support 960 separate data values.
14. The controller shall provide "continuous" automated loop tuning with an Adaptive Integral Algorithm Control Loop.
15. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.
    a. Discharge air control and low limit
    b. Pressure-dependent dual duct without flow mixing.
    c. Variable air volume with return flow tracking.
    d. Economizer with differential enthalpy.
    e. Minimum air flow coordinated with CO2.

2.10 ADVANCED VARIABLE AIR VOLUME CONTROLLER

A. The controller platform shall be designed specifically for room-level VAV control – pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO2, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, Series fan powered terminal unit, Parallel fan powered terminal unit, Supply and Exhaust air volume terminals, and Constant volume dual-duct terminal unit. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the "Sequence of Operation" as outlined in Section 4.

B. Minimum Requirements:
1. The controller shall be capable of either integrating with other devices or stand-alone room-level control operation.
2. The controller shall have an internal velocity pressure sensor.
    a. Sensor Type: Microbridge air flow sensor with dual integral restrictors.
    b. Operating Range: 0 to 1.5 in. H2O (0 to 374 Pa).
3. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for LonWorks™ network communications.
    a. FLASH Memory Capacity: 116 Kilobytes with 8 Kilobytes for application program.
    b. FLASH Memory settings retained for ten years.
    c. RAM: 8 Kilobytes
4. The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.
5. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
    a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
    b. Accuracy: ±1 minute per month at 77° F (25° C).
    c. Power Failure Backup: 24 hours at 32° to 100° F (0° to 38° C), 22 hours at 100° to 122° F (38° to 50° C).
6. The controller shall include Sylk Bus, a two wire, polarity insensitive bus that provides both 18 Vdc power and communications between a Sylk-enabled device and a Sylk-enabled controller.
7. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
8. The controller shall have an internal DC power supply to power external sensors.
    a. Power Output: 20 VDC ±10% at 75 mA.
9. The controller shall have a visual indication (LED) of the status of the devise:
    a. Controller operating normally.

b. Controller in process of download.
c. Controller in manual mode under control of software tool.
d. Controller lost its configuration.
e. No power to controller, low voltage, or controller damage.
f. Processor and/or controller are not operating.

10. The minimum controller Environmental ratings:
    a. Operating Temperature Ambient Rating: 32° to 122° F (0° to 50° C).
    b. Storage Temperature Ambient Rating: -40° to 122° F (-40° to 50° C).
    c. Relative Humidity: 5% to 95% non-condensing.
11. The controller shall have the additional approval requirements, listings, and approvals:
    a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
    b. CSA (LR95329-3) Listed
    c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
    d. Meets Canadian standard C108.8 (radiated emissions).
    e. Conforms to the following requirements per European Consortium standards:
    f. EN 61000-6-1; 2001 (EU Immunity)
    g. EN 61000-6-3; 2001 (EU Emissions)
12. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
13. The controller shall provide an integrated actuator option.
    a. Actuator type: Series 60 Floating.
    b. Rotation stroke: 95° ±3° for CW or CCW opening dampers.
    c. Torque rating: 44 lb-in. (5 Nm).
    d. Run time for 90° rotation: 90 seconds at 60 Hz.
14. The controller shall have sufficient on-board inputs and outputs to support the application.
    a. Analog outputs (AO) shall be capable of being configured to support 0-10 V, 2-10 V or 4-20 mA devices.
    b. Triac outputs shall be capable of switching 30 Volts at 500 mA.
    c. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring. Input and Output wiring terminals shall be designated with color coded labels.
    d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).
15. The controller shall provide for "user defined" Network Variables (NV) for customized configurations and naming using Niagara AX Framework™.
    a. The controller shall support a range of Network Variables to 240 with a byte count of 31 per variable.
    b. The controller shall support 960 separate data values.
16. The controller shall provide continuous automated loop tuning with an Adaptive Integral Algorithm Control Loop.
17. The controller shall have a loop execution response time of 1 second.
18. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.
    a. VAV terminal unit.
    b. Regulated air volume (room pressurization/de-pressurization).
    c. Room CO_2 control
    d. TOD occupancy sensor stand-by setpoints

2.11 GRAPHICAL USER INTERFACE SOFTWARE

A. Operating system currently in operation by the School District:

B. Upgrade GUI as required to include the addition of this new building system.
    1. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.12 LONWORKS NETWORK MANAGEMENT

A. The existing Graphical User Interface software (GUI) shall be modified if required to provide a complete set of integrated LonWorks network management tools for working with LonWorks networks. These tools shall manage a database for all LonWorks devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between LonWorks devices, known as "binding". Systems requiring the use of third party LonWorks network management tools shall not be accepted.

B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

C. The network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

D. These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.

E. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

2.13 DDE DEVICE INTEGRATION

A. The Network Area Controller shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The Network Area Controller shall act as a DDE client to another software application that functions as a DDE server.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of these devices into the FMCS. Objects provided shall include at a minimum:
1. DDE Generic AI Object
2. DDE Generic AO Object
3. DDE Generic BO Object
4. DDE Generic BI Object

2.14 MODBUS SYSTEM INTEGRATION

A. The Network Area Controller shall support the integration of device data from Modbus RTU, ASCII, or TCP control system devices. The connection to the Modbus system shall be via an RS-232, RS485, or Ethernet IP as required by the device.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the Modbus system data into the FPMS. Objects provided shall include at a minimum:
1. Read/Write Modbus AI Registers
2. Read/Write Modbus AO Registers
3. Read/Write Modbus BI Registers
4. Read/Write Modbus BO Registers

C. All scheduling, alarming, logging and global supervisory control functions, of the Modbus system devices, shall be performed by the Network Area Controller.

D. The FMCS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment utilizing Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning

2.15 OPC SYSTEM INTEGRATION

A. The Network Area Controller shall act as an OPC client and shall support the integration of device data from OPC servers. The connection to the OPC server shall be Ethernet IP as required by the device. The OPC client shall support third party OPC servers compatible with the Data Access 1.0 and 2.0 specifications.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the OPC system data into the BAS. Objects provided shall include at a minimum:
1. Read/Write OPC AI Object
2. Read/Write OPC AO Object
3. Read/Write OPC BI Object
4. Read/Write OPC BO Object
5. Read/Write OPC Date/Time Input Object
6. Read/Write OPC Date/Time Output Object
7. Read/Write OPC String Input Object
8. Read/Write OPC String Output Object

C. All scheduling, alarming, logging and global supervisory control functions, of the OPC system devices, shall be performed by the Network Area Controller.

D. The FMCS supplier shall provide an OPC client communications driver. The equipment system vendor that provided the equipment utilizing OPC shall provide documentation of the system's OPC server interface and shall provide factory support at no charge during system commissioning.

2.16 OTHER CONTROL SYSTEM HARDWARE

A. Space Temperature Wall Module: Temperature sensing modules mounted on the wall in occupied spaces. Optional setpoint, indication, and override switches must be provided as specified.
1. Manufacturers: Subject to compliance with requirements. Provide products by one of the manufacturers specified to match the existing School District system.
   a. Honeywell

2. Wall module shall have a thermistor temperature sensor with operating range of 45 to 99 deg. F. designed for mounting on a standard electrical switch box.
3. The controller shall include Sylk Bus, a two wire, polarity insensitive bus that provides both 18 Vdc power and communications between a Sylk-enabled device and a Sylk-enabled controller.
4. Space temperature sensors shall be accurate to plus or minus 0.5 deg. F at 77 deg. F.
5. Where specified, space temperature sensors shall have a setpoint knob calibrated for warmer-cooler adjustments (calibrated to allow plus or minus adjustments to a software setpoint).
5. Where specified, wall module shall also have an after-hours override pushbutton and LED override indicator.
7. Where specified, wall module shall have an LCD display with 2 level user access. Level one access shall be available for typical occupant adjustments, and level two access for system configuration. Level two access shall be accessible only via password or multi-key code input. Room temperature, room temperature setpoint, VAV balancing parameters and settings, occupancy override, and other control parameters for a total of at least 35 items shall be available via the keypad/display. Wall module screens shall be configurable for typical tenant and control contractor views.

B. Duct Mount, Pipe Mount, and Outside Air Temperature Sensors:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified to match the existing School District system.
   a. Honeywell
2. Outside air sensors shall include an integral sun shield.
3. Temperature sensors shall have an accuracy of plus or minus 1.0 deg. F. over operating range.
4. Duct sensors shall have sensor approximately in center of the duct, and shall have selectable lengths of 6, 12, and 18 inches.
5. Multipoint averaging element sensors shall be provided where specified, and shall have a minimum of one foot of sensor length for each square foot of duct area (provide multiple sensors if necessary).
6. Pipe mount sensors shall have copper, or stainless steel separable wells.

C. Current Switches: Solid state, split core, current switch that operates when the current level (sensed by the internal current transformer) exceeds the trip point shall be provided where specified.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. ACI
   b. Honeywell
   c. RIB, Inc.
   d. Veris Industries
2. Sensing range 0.5 – 250 Amps.
3. Output 0.3 A @ 200 VAC/VDC / 0.15 A @ 300 VAC/VDC
4. Operating frequency 40 Hz -1 kHz.
5. Operating Temperature 5-104 deg. F (-15 – 40 deg. C), Operating Humidity 0-95% non-condensing
6. Approvals CE, UL.

D. Current Sensors: Solid state, split core linear current sensors shall be provided where specified.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. ACI
   b. Honeywell
   c. RIB, Inc.
   d. Veris Industries
2. Linear output of 0-5 VDC, 0-10 VDC, or 4-20 mA.
3. Scale sensors so that average operating current is between 20-80% full scale.
4. Accuracy plus or minus 1.0% (5-100% full scale)
5. Operating frequency 50-600 Hz.
6. Operating Temperature 5-104 deg. F (-15 – 40 deg. C), Operating Humidity 0-95% non-condensing
7. Approvals CE, UL.

E. Water Flow Meters: Water flow meters shall be axial turbine style flow meters which translate liquid motion into electronic output signals proportional to the flow sensed.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Fluid Components International
   b. Hersey Meters
   c. Onicon Meters
2. Flow meters shall be ‘insertion’ type complete with ‘hot-tap’ isolation valves to enable sensor removal without water supply system shutdown.
3. Accuracy shall be + 2% of actual reading from 0.4 to 20 feet per second flow velocities.

F. Low Temperature Limit Switches. Safety low limit shall be manual reset twenty foot limited fill type responsive to the coolest section of its length.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
    a. Honeywell
2. Low Limit Setpoint shall be adjustable between 20 and 60 deg. F. (-5 and 15 deg. C.)
3. Switch enclosure shall be dustproof and moisture-proof.
4. Switch shall break control circuit on temperature fall. Contact ratings shall be 10.2 FLA at 120 VAC, and 6.5 FLA at 240 VAC.
5. Ambient Temperature range -20 to 125 deg. F. (-11 to 52 deg. C.)
6. Operating Temperature Range 20 to 60 deg. F. (-5 to 15 deg. C.)

G. High Temperature Limit Switches. Safety high limit (fire stats) shall be manual reset type.
1. Manufacturers: Subject to compliance with requirements, provide products the manufacturers specified.
    a. Honeywell
2. High Limit Setpoint shall be adjustable between 100 and 240 deg. F. (38 and 116 deg. C.)
3. Switch enclosure shall be dustproof and moisture-proof.
4. Switch shall break control circuit on temperature fall. Contact ratings shall be 10 FLA at 120 VAC, and 5 FLA at 240 VAC.
5. Ambient Temperature range -20 to 190 deg. F. (-28 to 88 deg. C.) at case, and 350 deg. F (177 deg. C.) at the sensor.
6. Operating Temperature Range 100 to 240 deg. F. (38 to 116 deg. C.)

H. CO2 Sensors.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
    a. Honeywell
    b. TelAire
    c. Vaisala
2. Carbon Dioxide sensors shall be 0-10 Vdc, 2-10 Vdc, or 4-20 mA linear analog output type, with corrosion free gold-plated non-dispersive infrared sensing, designed for duct or wall mounting.
3. Sensor shall incorporate internal diagnostics for power, sensor, analog output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-2000 PPM with +/- 75 PPM accuracy at full scale.
4. Where specified, sensor shall have an LCD display that displays the sensor reading and status.

I. Differential Pressure Sensors
1. Manufacturers:
    a. ACI
    b. Honeywell
    c. RIB, Inc.
    d. Veris Industries
2. Sensor shall have four field selectable ranges: 0.1, 0.24, 0.5, 1.0 in w.c. for low pressure models, and 1.0, 2.5, 5, 10 for high pressure models.
3. Sensor shall provide zero calibration via pushbutton or digital input.
4. Sensor shall have field selectable outputs of 0-5 VDC, 0-10 VDC, and 4-20 mA
5. Where specified, sensor shall have and LCD display that displays measured value.
6. Sensor overpressure rating shall be 3 PSID proof, and 5 PSID burst.
7. Sensor accuracy shall be plus or minus 1% FS selected range.

J. Standard Automatic Control Dampers. Provide all automatic control dampers not specified to be integral with other equipment.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
    a. Greenheck
    b. Honeywell
    c. Johnson Controls
    d. Ruskin
2. Frames shall be 5 inches wide and of no less than 16-gauge galvanized steel. Inter-blade linkage shall be within the frame and out of the air stream.
3. Blades shall not be over 8 inches wide or less than 16-gauge galvanized steel triple V type for rigidity.
4. Bearings shall be acetyl, oilite, nylon or ball-bearing with ½ inch diameter plated steel shafts.
5. Dampers shall be suitable for temperature ranges of -40 to 180F.
6. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.
7. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6". Dampers with dimensions of 24 inches and less shall be rated for 3,000 fpm velocity and shall withstand a maximum system pressure of 5.0 in. w.c. Dampers with dimensions of 36 inches and less shall be rated for 2,500 fpm velocity and shall withstand

a maximum system pressure of 4.0 in. w.c. Dampers with dimensions of 48 inches and less shall be rated for 2,000 fpm velocity and shall withstand a maximum system pressure of 2.5 in. w.c. Damper blade width shall be no greater than 8 inches, and dampers over 48 inches wide by 74 inches high shall be sectionalized.

8. Maximum leakage for dampers in excess of sixteen inches square shall be 30 CFM per square foot at static pressure of 1 inch of WC. Testing and ratings to be in accordance with AMCA Standard 500.

K. Low Leakage Automatic Control Dampers. Provide all automatic control dampers not specified to be integral with other equipment.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Greenheck
   b. Honeywell
   c. Johnson Controls
   d. Ruskin
2. Frames shall be 5 inches wide and of no less than 16-gauge galvanized steel. Inter-blade linkage shall be within the frame and out of the air stream.
3. Blades shall not be over 8 inches wide or less than 16-gauge galvanized steel triple V type for rigidity.
4. Bearings shall be acetyl, oilite, nylon or ball-bearing with ½ inch diameter plated steel shafts.
5. Dampers shall be suitable for temperature ranges of -40 to 180F.
6. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.
7. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6". Dampers with dimensions of 24 inches and less shall be rated for 3,000 fpm velocity and shall withstand a maximum system pressure of 5.0 in. w.c. Dampers with dimensions of 36 inches and less shall be rated for 2,500 fpm velocity and shall withstand a maximum system pressure of 4.0 in. w.c. Dampers with dimensions of 48 inches and less shall be rated for 2,000 fpm velocity and shall withstand a maximum system pressure of 2.5 in. w.c.
8. Side seals shall be stainless steel of the tight-seal spring type.
9. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage data for all low leakage control dampers with the temperature control submittal.
10. Maximum leakage for low leakage dampers in excess of sixteen inches square shall be 8 CFM per square foot at static pressure of 1 inch of WC.
11. Low leakage damper blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage.
12. Testing and ratings shall be in accordance with AMCA Standard 500.
13. Damper blade width shall be no greater than 8 inches, and dampers over 48 inches wide by 74 inches high shall be sectionalized. Testing and ratings to be in accordance with AMCA Standard 500.

L. Round Motorized Dampers. Round dampers shall be provided where specified and shall be factory mounted in a section of round duct a minimum of 12 inches long, but no less than one inch longer than the duct diameter.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Greenheck
   b. Honeywell
   c. Johnson Controls
   d. Ruskin
2. Duct shall be sleeve type spiral duct crimped on the downstream end, 24 gage galvanized minimum except duct over 12 inches in diameter shall be 22 gage.
3. Duct shall have an integral galvanized steel actuator mounting plate and a ½ inch zinc-coated steel blade shaft extending a minimum of 2 inches beyond the actuator mounting plate.
4. Shaft bearings shall be flanged bronze oilite pressed into the frame.
5. The blade shall be a minimum 16 gage galvanized steel, and damper frame shall be provided with closed-cell neoprene seals with silicone rubber bead. Damper shall be designed for a 2500 ft/min approach velocity and a 4 inch minimum static pressure.
6. Damper shall be suitable for operation from 32 to 130F temperatures.
7. Damper and actuator combination shall be designed for leakage rates less than 13 cfm per square foot at one inch w.c. differential and 25 cfm at four inches w.c. Actuator shall have an external declutch lever to allow manual blade positioning during equipment and power malfunctions.

M. Control Valves: (Globe Type) Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Honeywell
   b. Johnson Controls
2. Two-position valves shall be line size.

3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's specified maximum differential pressure shall not be exceeded in order to prevent cavitation.
4. Two-way proportional valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through, and linear through the bypass. Rangeability shall be 50:1 or greater.
5. Provide valve position indicator and a method to operate valves manually during system start-up, or actuator power loss or failure on all valves.
6. Leakage rate shall be no more than ANSI Class III (for heating) or ANSI Class IV (for cooling).
7. Valves 1/2 inch through 3 inches shall be screwed pattern except where solder connections are specified for valves 1/2 or 3/4 inches.
8. Three-way valve bypass ports shall be of Cv to provide constant flow through the control loop.
9. Two-way valves shall close off against the net differential pressure resulting from the maximum head pressure of the system pumps less all loop pressure losses. Three-way valves shall close off against the difference in head pressure between the controlled load and the bypass line.
10. Valves 2-1/2 inch and larger shall be flanged and ANSI/ASME-rated to withstand the pressures and temperatures specified.
11. Valves shall have stainless-steel stems and spring loaded Teflon packing with replaceable discs.

N. Control Valves: (Characterized Ball Valves) Control valves 1/2 to 3 inches shall be 2-way or 3-way forged brass screwed pattern constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Honeywell
   b. Johnson Controls
   c. Griswold Controls
2. Two-position valves shall be line size.
3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's specified maximum differential pressure shall not be exceeded in order to prevent cavitation.
4. Two-way proportional valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through and linear flow through the bypass. Rangeability shall be 100:1 or greater.
5. A-port leakage rate shall be ANSI Class IV (no more than 0.01% of Cv) or better.
6. Fluid temperature range shall be between -22 and +250 degrees F. water or glycol solutions up to 50%. Piping and valves shall be properly insulated to prevent formation of ice on moving parts.
7. Valves shall be rated for no less than 360 psig at 250 degrees F.
8. Provide a method to operate valves manually during actuator power loss or failure.
9. Two-way valves shall close off against 70 psi minimum, and three-way valves shall close off against 40 psi minimum.
10. Valves ball and stern shall be 316 stainless-steel.
11. Actuator shall be available with NEMA 3R (IP54) rated enclosure suitable for outdoor installation.
12. Valves shall be tagged with Cv rating and model number.

O. Control Valves: (Characterized Ball Valves) Control valves 4 to 6 inches shall be 2-way or 3-way cast iron ANSI Class 125 flanged connections as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Honeywell
   b. Johnson Controls
   c. Griswold Controls
2. Two-position valves shall be line size.
3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's maximum differential pressure shall not be exceeded in order to prevent cavitation.
4. Two-way water valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through and linear with 20% reduced flow through the bypass. Rangeability shall be 100:1 or greater.
5. A-port leakage rate shall be ANSI Class IV (no more than 0.01% of Cv) or better.
6. Fluid temperature range shall be between -22 and +250 degrees F. water or glycol solutions up to 50%. Piping and valves shall be properly insulated to prevent formation of ice on moving parts.
7. Valves shall be rated for no less than 240 psig at 250 degrees F.
8. Provide a method to operate valves manually during actuator power loss or failure.
9. Two-way valves shall close off against 70 psi minimum, and three-way valves shall close off against 40 psi minimum.

10. Valve ball and stem shall be 316 stainless-steel.
11. Actuator shall be available with NEMA 3R (IP54) rated enclosure suitable for outdoor installation.
12. Valves shall be tagged with Cv rating and model number.

P. Butterfly Control Valves: Where specified, butterfly control valves 2” to 20" in size shall be cast iron body type for 2-way applications and constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Three-way applications shall consist of 2-way valves assembled to a "Tee" fitting with common actuators and operating linkage.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
    a. Bray
    b. Honeywell
    c. Johnson Controls
    d. Tyco International
2. Valves shall have tapped lugs for standard flange connection, and meet ANSI/ASME requirements to withstand the pressures and temperatures encountered.
3. Valve shall have a corrosion, ultra-violet, and wear-resistant coating for outdoor applications.
4. Resilient-seated valves shall use food-grade elastomeric seats. Seat shall also function as the flange gaskets.
5. Valves shall be designed for isolation and the absence of downstream piping at rated differential pressure.
6. All valves shall be line size.
7. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psid at rated flow (except as may be noted on the drawings) up to a maximum stroke of 60° disk rotation. Manufacturer's maximum fluid velocity shall not be exceeded in order to prevent cavitation.
8. Valves shall be rated for bubble tight shutoff at no less than 150 psi differential pressure for full cut valves, or 50 psi for undercut valves.
9. Valve disc shall be of corrosion-resistant construction appropriate for the controlled media such as nylon-coasted cast iron, aluminum bronze, or stainless steel.
10. Valve stems shall be stainless steel, with inboard top and bottom bearings, and an external corrosion resistant top bearing to absorb actuator side thrust.
11. Actuator mounting flange shall conform to ISO 5211 for actuator interchangeability.
12. Actuator shall be available with NEMA 4X (IP65) rated enclosure suitable for outdoor installation.
13. Valves shall be tagged with Cv rating and model number.

Q. Actuators, General. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off. Valves shall be provided with actuators suitable for floating or analog signal control as required to match the controller output. Actuators shall be power failure return type where valves or dampers are required to fail to a safe position and where specified.

R. Non-Spring Return Low Torque Direct Coupled 35 & 70 lb-in Actuators. Actuators shall be 35 or 70 lb-in. with strokes adjustable for 45, 60, or 90 degree rotation applications and designed for operation between 20 and 125 F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
    a. Honeywell
    b. Johnson Controls
    c. Siemens Building Technologies
    d. TAC
2. Each actuator shall also have a minimum position adjustable rotation of 0 to 30 degrees.
3. Actuators shall be for floating or two position (ML 6161 or ML6174) control, or for 4-20 mA or 2-10Vdc (ML7161 or ML7174) input signals.
4. Analog control actuators shall have a cover mounted direct/reverse acting switch.
5. Actuator motor shall be magnetically coupled or shall have limit switch stops to disengage power at the ends of the stroke.
6. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.
7. Actuators shall have NEMA 1 environmental protection rating and be 24 volt and UL listed with UL94-5V plenum requirement compliance.
8. Minimum design life of actuators shall be for 1,500,000 repositions and 35 lb-in. models shall be designed for 50,000 open-close cycles and 70 lb-in. models shall be designed for 40,000 open-close cycles.
9. Actuator options shall include 1) Auxiliary feedback potentiometers, 2) open-closed indicator switches, 3) actuator timings of 90 seconds, 3 minutes, or 7 minutes, one or two auxiliary switches, and 4) torque of 35 or 70 lb-in.

U. Non-Spring Return High Torque 177 and 300 lb-in Actuators. Actuators shall be UL listed 24 Vac in NEMA 2 enclosures designed for operation between -5 and 140 F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
    a. Honeywell

b. Johnson Controls
c. Siemens Building Technologies
d. TAC

2. Rotation direction shall be switch selectable.
3. Minimum design life of actuators shall be for 1,500,000 repositions and for 60,000 open-close cycles.
4. Actuators shall be suitable for the controller output signals encountered, floating or analog, and shall have full cycle timing of 95 seconds.
5. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.

S. Spring Return Direct Coupled Actuators. Actuators shall have torque ratings of 44lb-in., 88 lb-in., or 175 lb-in. Actuators shall be modulating 90 seconds nominal timing or two-position 45 seconds nominal timing types with strokes for 90 degree rotation applications and designed for operation between -40 and 140 F.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Honeywell
   b. Johnson Controls
   c. Siemens Building Technologies
   d. TAC
2. Each torque rating group shall have optionally selected control types, floating control, 2-position 24 Vac, 2-position line voltage, or analog input which is switch selectable as 0-10Vdc, 10-0 Vdc, 2-10 Vdc, or 10-2 Vdc.
3. Actuator spring return direction (open or closed) shall be easily reversed in the field, and actuators shall spring return in no greater than 20 seconds.
4. Actuators shall be direct connected (no linkages), and shall have integral position indication.
5. Actuators shall have NEMA 2 environmental protection rating, and UL approved and plenum rated per UL873.
6. Minimum design life of modulating actuators shall be for 1,500,000 repositions and 60,000 spring returns, except 2-position actuators shall be for 50,000 spring returns.
7. Each actuator shall be provided with a manual power-off positioning lever for manual positioning during power loss or system malfunctions, including a gear-train lock to prevent spring action.
8. Upon power restoration after gear lock, normal operation shall automatically recur.

T. Fast Acting Two Position Fire & Smoke Actuators. Fire/smoke damper actuators shall be direct connected (no linkages) two-position spring return types with stroke for 90 degree nominal rotation applications and designed for 60,000 full stroke cycles and normal operation between 0 and 130 F.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Honeywell
   b. Siemens Building Technologies
2. Actuators control shall be compatible with SPST control switch and with torque ratings of 30 lb-in.
3. Actuator timing shall be 25 seconds maximum in powered instances and shall spring-return in 15 seconds.
4. Actuators shall be UL listed with UL873 plenum rating with die-cast aluminum housing with integral junction box and conduit knockouts, and designed to operate reliably in smoke control systems requiring UL555S ratings up to 350F.
5. The actuator shall be designed to operate for 30 minutes during a one-time excursion to 350F.
6. Actuator shall require no special cycling during long-term holding, and shall “hold” with no audible noise at a power consumption of approximately half of the driving power.
7. Actuators shall be 24 volt or 120 volt with models for clockwise (add a B suffix) and counter-clockwise (add an A suffix) spring return.

U. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Control panels shall meet all requirements of Title 24, California Administrative Code. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of ‘as-built’ control drawings (relating to the controls within that panel) shall be furnished within each control panel.

PART 3 EXECUTION

3.1 INSTALLATION

A. All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of Honeywell integrated control systems. The installing office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.

B. Install system and materials in accordance with manufacturer’s instructions, and as detailed on the project drawing set.

C. Drawings of the TCS and FMCS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.

D. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by this contractor in accordance with these specifications.

E. Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by this contractor.

3.2 WIRING

A. All electrical control wiring from the control panels to the equipment, NAC, computers and network components shall be the responsibility of this contractor.

B. The electrical contractor (Section 26) shall furnish all power wiring to electrical starters and motors and power wiring to the central control panels.

C. The Electrical Contractor shall rough-in sensor boxes and run conduit to accessible space above ceilings.

D. All wiring shall be in accordance with the Project Electrical Specifications (Section 26), the National Electrical Code and any applicable local codes. All FMCS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Section 26) unless otherwise allowed by the National Electrical Code or applicable local codes. Where FMCS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this contractor at no expense to the Owner

3.4 WARRANTY ACCESS

A. The Owner shall grant to this contractor, reasonable access to the TCS and FMCS during the warranty period.

B. The owner shall allow the contractor to access the TCS and FMCS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 ACCEPTANCE TESTING

A. Upon completion of the installation, this contractor shall load all system software and start-up the system. This contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. This contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

D. System Acceptance: Satisfactory completion is when this contractor and the Section 26 contractor have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 OPERATOR INSTRUCTION, TRAINING

A. During system commissioning and at such time acceptable performance of the TCS and FMCS hardware and software has been established this contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. This contractor shall provide 24 hours of instruction to the owner's designated personnel on the operation of the TCS and FMCS and describe its intended use with respect to the programmed functions specified. Operator orientation of the systems shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

C. The training shall be in three sessions as follows:
   1. Initial Training: One day session (6 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.
   2. First Follow-Up Training: One day session (6 hours) approximately two weeks after initial training.
   3. Warranty Follow Up: Two days (12 hours total) in no less than 4 hour increments, to be scheduled at the request of the owner during the one year warranty period. These sessions shall cover topics as requested by

the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

END OF SECTION 230950

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 DEFINITIONS

A. CPVC: Chlorinated polyvinyl chloride.

B. PVC: Polyvinyl chloride.

1.4 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.

1.5 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.

1.6 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.

1.7 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.
   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. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

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 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F 441, Schedules 40 and 80, plain ends.

B. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends.

C. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
1. CPVC Solvent Cement: ASTM F 493.

D. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.
1. PVC Solvent Cement: ASTM D 2564.

2.6 VALVES

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

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

C. 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. Plastic Ball Valves: 150-psig working pressure, 250 deg F maximum operating temperature, full port design, 1- or 2-piece body design, CPVC body and ball, polytetrafluoroethylene seats, EPDM seals, and tee handle; with threaded, socket, union, or flanged connections.

I. Plastic Butterfly Valves: 150-psig working pressure, 250 deg F maximum operating temperature, PVC wafer body, polytetrafluoroethylene seats, lever lock handle, and wafer style for installation between flanges.

2.7 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. 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.

L. 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.

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.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Heat Pump 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. Heat Pump 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.

B. 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.

3.10 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.

3.11 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 232113

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 232118

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 SUSPENDED WET PIT PUMPS

A. The pump casing shall have an integrally cast discharge flange. The suction strainer shall be fabricated 304 stainless steel with iron bottom plate.

B. The impeller shall be semi-open and capable of passing 1 3/8" solids. The impeller shall contain a balancing ring and be cast in iron and be secured to shaft by taper fit, with Woodruff key, castellated nut, washer and cotter pin.

C. All shafting shall be 316 stainless steel and shall be a minimum of 1 1/4" diameter between the coupling and the impeller. Column pipe shall be steel with welded flanges machined for registered fit.

D. The pump bearing, located directly above impeller, shall be of bronze. Bearing housing shall be of 316 stainless steel.

E. An intermediate bearing of the same materials as the pump bearing must be provided on pumps in excess of 6'-0" in length. On intermediate bearing for each additional 5'-0" pump length shall be furnished.

F. Pump and intermediate bearings shall be water lubricated through separate lubrication lines terminating at the cover plate.

G. The motor support shall be of cast iron, machined to assure positive alignment of motor and pump shaft, fitted with a high thrust angular contact bearing with moisture-proof enclosure and grease seals. External impeller and shaft axial adjustment shall be provided.

H. Water make-up operation shall be controlled by a float operated switch. Float rod shall be fiberglass. Float shall be 304 stainless steel. Float stops shall be 304 stainless steel.

I. The flexible coupling between the motor and pump shafts shall be Woods Sure-Flex spacer type coupling.

J. Pumps shall be driven by a standard "C" face vertical electric motor.

2.3 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

2.4 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

2.5 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

2.6 IN-LINE CIRCULATORS

A. Bronze fitted with ceramic seal, spring coupling, and 1750-rpm, drip-proof motor with overload protection.

B. Substantially supported in piping with a full size leg to floor.

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

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 232123

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. Hydronic Heat Pump Closed Loop Cleaning
1. Prior to any introduction of fluids to the closed loop system the Mechanical Contractor shall close isolation valves at each heat pump 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.

E. Fluid Cooler Chemical Treatment Station
1. A chemical treatment station shall be provided by the Treatment Contractor in a 24" x 24" locked cabinet. Station shall include LMI DC4000-1-1 conductivity meter with sensor and A-17-1-1351S chemical pump, or approved equal. The chemical station shall be located inside the mechanical room. Mechanical Contractor shall provide ¾" PVC piping from the discharge of the spray pump of the fluid cooler to the station enclosure with T's for installation of the conductivity sensor and for chemical injection. This contractor shall also provide return piping back to the fluid cooler sump at the opposite end from the spray pump pickup. The Treatment Contractor shall install the conductivity sensor and injection fitting in the T's provided and set up initial treatment.
2. Under the scope of this specification the Treatment Contractor shall monitor the tower sump and adjust feed and bleed to maintain proper control of scale and corrosion for a period of one year. At a minimum tower treatment shall be check monthly from May until October. The Treatment Contractor shall provide all chemical required during the first year of operation

END OF SECTION 232125

SECTION 23 2166 - SPLIT SYSTEM HEAT PUMP UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
   1. Furnish and install heat pumps as described in Contract Documents.

B. Related Sections
   1. Section 02776 - Concrete pads
   2. Section 23 0501 - Common HVAC Requirements

1.2 SUBMITTALS

A. Quality Assurance / Control - Equipment check-out sheets

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies - Each unit shall be UL or ETL labeled.

1.4 WARRANTY

A. Provide five year warranty on compressors beginning from date of start-up. Record start-up date on warranty certificate for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Heat Pumps
   1. Indoor Units -
      a. Compact wall mounted units.
      b. Supplementary electric heater, size as scheduled.
      c. Cabinet finish as selected by Architect.
      d. Isolate moving parts from cabinets to reduce noise.
   2. Outdoor Units -
      a. Compressor shall be of rotary or scroll design.
      b. Fans shall be direct driven and discharge horizontally.
      c. Casing shall be fully weatherproof for outdoor installations.
      d. Microprocessor Controls shall be factory wired with field installed remote pendant station.
      e. Refrigerant shall be R-410A.
      f. Isolate moving parts from cabinets to reduce noise.
      g. Use dry-charged tubing for connection of unit's refrigerant system.
   3. Approved Products -
      a. Model 53QYE018 by Carrier Corp, Syracuse, NY (800) 227-7437 or (315) 432-6000 www.carrier-commercial.com
      b. Model M18YB by Friedrich Air Conditioning Co, Austin, TX (800) 541-6645 or (210) 225-2000 www.friedrich.com
      c. Mr Slim Model PKH-18EK by Mitsubishi Electronics America Inc, HVAC Div, Norcross, GA (800) 421-1140 or (770) 448-1268
      d. Model 18KHS22 by Sanyo Air Conditioning Products, Chatsworth, CA (818) 998-7322 www.sanyo.com
      e. L.G. Electronics, USA, Englewood Cliffs, NJ (201) 585-0018, www.lghvac.com

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Manufacturer's Field Service - Units shall be started up, checked out, and adjusted by Unit Manufacturer's authorized factory trained service mechanic. Use equipment check-out sheet provided by Manufacturer. Complete and sign all items on sheet.

END OF SECTION 232166

SECTION 23 2200 - WATER SOURCE HEAT PUMP SYSTEM

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 water source heat pump system as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Units of the type furnished shall have been in successful operation at least five years.

B. Units shall be UL listed and ARI certified, and shall be in accordance with the Canadian Standards Association (CSI).

C. The units shall have ARI, UL, and CSI labels.

D. All units shall be factory tested under normal operation conditions and normal water flow rates. Units that are tested without water flow are not acceptable.

E. Units shall be Climate Master, Trane or Mammoth.

1.4 WARRANTY

A. Compressors shall be provided with five-year warranties.

PART 2 - PRODUCTS

2.1 GENERAL

A. System shall consist of water-to-air reverse cycle air conditioning units of the type, size, capacity, and style scheduled on the drawings.

B. Units shall be interconnected thru a non-refrigerated central water system, maintained within an approximate temperature range of 40 degrees F. to 110 degrees F. by means of a supplementary heat source and closed circuit evaporative type water cooler.

C. Piping system shall be two-pipe reverse-return as shown on the plans complete with primary and standby circulating pumps.

D. Individual room temperature control including necessary safety and operating controls shall be furnished as integral or accessory parts of the air conditioning units.

2.2 ELECTRO-HYDRONIC WATER SOURCE HEAT PUMPS

A. Refrigeration Circuit:
   1. Units shall have a sealed refrigerant circuit including:
      a. A hermatic compressor.
      b. A refrigerant metering device.
      c. A finned tube refrigerant to air heat exchanger.
      d. A reversing valve.
      e. A coaxial (tube in tube) refrigerant to water heat exchanger.
      f. Safety controls including a high pressure switch, a low pressure sensor, and a low water temperature (thermostat) switch.
   2. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service.
   3. Activation of any safety device shall prevent compressor operation via a lock out relay. The lockout relay shall be reset at the thermostat or at the contract furnished disconnect switch. Units which may be reset at the disconnect switch only are not acceptable.

4. Hermetic compressors shall be internally sprung, externally isolated, with thermal overload protection and shall be located in an insulated compartment to minimize sound transmission. Units above 15,000 BTUH shall have the compressor mounted on spring isolators to reduce noise and vibration transmission. Rubber mounts for these larger units are not acceptable.
5. Refrigerant to air heat exchangers shall utilize enhanced aluminum finns and rifled copper construction rated to withstand 425 psi refrigerant working pressure.
6. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 450 psi working refrigerant pressure and 400 psi working water pressure.
7. Refrigerant metering shall be accomplished by capillary tubes for units intended for use in standard operating ranges, or expansion valves for units intended for use in expanded operating ranges.
8. Reversing valves shall be four-way solenoid activated refrigerant valves which shall fail to heating operation should the solenoid fail to function.

B. Fan and Motor Assembly:
1. Units rated 60,000 BTUH and under shall have a direct drive centrifugal fan. The fan motor shall be 3-speed permanently lubricated, PSC type with thermal overload protection. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor shall be isolated from the fan housing by torsionally flexible isolation. Units 72,000 BTUH and above shall have a belt drive fan assembly. The assembly shall include a forward curved fan wheel, housing, solid steel fan shaft encased in ball bearings, fan pulley and adjustable motor sheave. The motor shall be a three phase, open type with external thermal overload protection. The motor shall be mounted on an adjustable base for proper belt tension. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. External static pressure rating of the unit shall be based on a wet coil. Ratings based on dry coil shall not be acceptable.

C. Electrical:
1. A control box shall be located within the unit and shall contain a transformer, controls for compressor, reversing valve and fan motor operation and shall have a terminal block for low voltage field wiring connections. Open controls in the air stream will not be acceptable. Units shall be name plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 volts and shall provide heating or cooling as required by the wall thermostat. Two compressor units shall have a solid state time delay to prevent both compressors from starting simultaneously. Provide integral interface for DDC control.

D. Solid State Control System (Optional):
1. Units shall have a solid state control system. The control shall interface with any type of wall thermostat mechanical or electronic. The control system shall have the following features:
    a. Anti-short cycle time delay on compressor operation, time delay shall be five (5) minutes minimum.
    b. Random start on power up mode or return from night setback.
    c. Minimized reversing valve operation for extended life and quiet operation.
    d. Night setback override from low temperature thermostat.
    e. Two (2) hour override initiated by a signal from wall thermostat.
    f. Low voltage protection.
    g. High voltage protection.
    h. Ability to work with any thermostat.
    i. Single grounded wire to initiate night setback, demand load shed, or emergency shutdown.
    j. Unit shutdown on high or low refrigerant pressures.
    k. Unit shutdown on low water temperature.
    l. Option to reset unit at thermostat or disconnect.
    m. Automatic intelligent reset. Unit shall automatically reset the unit 10 minutes after trip if the fault has cleared. Should a fault re-occur within 30 minutes after reset, the permanent lockout will occur.
    n. Ability to defeat time delays for servicing.
    o. Light emitting diodes (LED) to indicate high pressure, low pressure, low voltage, high voltage, freeze protection, condensate overflow and control voltage status.
    p. Control logic shall only move the reversing valve when cooling is called for the first time. The reversing valve shall be held in this position until the first call for heating. This scheme ensures quiet operation and increased valve life. Only control schemes that provide this reduced reversing valve operation will be accepted.
    q. Control board shall have an eight (8) pin plug to allow the future addition of RS485 DDC circuitry. Control boards that cannot be upgraded to DDC by plugging in a module shall not be allowed.
    r. Control board shall allow up to three (3) units to be operated from one thermostat without any auxiliary controls.
    s. Optional 24 volt relay shall be required to provide dry contact alarm when used with a DDC system.

E. Basic Construction:
1. Horizontal units shall be fabricated from heavy gauge (GS90) galvanized sheet metal. All interior surfaces shall be lined with 1/2 inch, 1 1/2 lb. acoustic type glass fiber insulation. All fiberglass shall be coated and have exposed edges tucked under flanges to prevent the introduction of glass fibers into the airstream. All

insulation must bee NFPA 90A. Vertical unit shall be as above except the cabinet will have a painted baked enamel finish.

2. All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the airstream are not acceptable. Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. Supply and return water connections shall be copper FPT fittings and shall be securely mounted flush to the cabinet allowing for connection to a flexible hose without the use of a back-up wrench. Water connections which protrude through the cabinet or require the use of a backup wrench shall not be allowed.
3. To facilitate installation in minimal space requirements, units rated 30,000 BTUH and under shall have all electrical and water connections on the end of the cabinet opposite the duct connections. Contractor shall be responsible for any extra costs involved in the installation of units which do not have this feature. Contractor must also ensure that non-specified units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.
4. Units shall have the air flow arrangements as shown on plans.
5. Sound attenuation:
    a. All units 15,000 BTUH and up must have a compressor discharge muffler.
    b. Compressor side panels and base pan must have closed cell insulation rated at 5 lb/cu. ft. density.
    c. All reciprocating compressors must have high density damping material applied to the compressor shell.
    d. All units 15,000 BTUH and up shall have the compressors mounted on springs.

F. Air Filters:
1. Units shall have a factory installed two (2) inch thick filter bracket for side filter removal. Units shall have a two (2) inch thick pleated 30% efficient filter. Contractor shall be furnished one (1) set of spare filters to be turned over to Owner on completion of start-up. Filters shall be standard filter sizes. If units utilize non-standard filter sizes, then the contractor shall provide 4 spare sets of filters for each unit.

G. Units shall be furnished with a condensate overflow switch.

H. Each individual horizontal or vertical heat pump will have a minimum EER of 10.5 or higher, and a heating COP of 3.8 or higher.

I. Economizer and Mixing Damper Section:
1. Enthalpy O.A. Change-Over Control - measures the total heat content of the air (temperature and humidity).
2. Damper Motor - heavy duty spring return, modulating motor.
3. Economizer Systems - wired to a terminal block complete with transformer, crank arms, swivels and push rods. Available for primary voltages of 208/240, 277 or 480 V.
4. Sequence of Operation - during the cooling cycle the system operates as follows: On a call for cooling by the indoor space thermostat, the damper motor will be energized if the outdoor air conditions are adequate for "free cooling." The outdoor air damper is modulated by the mixed air temperature controller. During economizer operation the mechanical cooling is locked out and the economizer functions as a first stage of cooling.
    a. The compressor will cycle to maintain space temperature when the outdoor air conditions are not fully adequate. When the outside air is above the changeover set point, the outdoor air damper closes to its minimum position. If the space thermostat is calling for cooling, the compressor will start.
    b. During the heating cycle the economizer system is automatically locked out, providing maximum fuel economy.
    c. The economizer closes the outdoor air damper and opens the return air damper when the supply fan is turned off. The economizer accomplishes this when the transformer is wired into the load side of the fan circuit.

2.3 PIPING, PUMPS AND ACCESSORIES

A. Water piping system shall be installed in accordance with the accompanying drawings to provide a self-balancing two-pipe reverse return arrangement.

B. Piping shall be graded to prevent air pockets and to enable any entrained air to rise in the direction of flow. Provide air vents where there is a possibility of collecting air.

C. Provide supply and return connections at each air conditioning unit location shown, plus any possible future locations as shown, to permit expansion or normal relocation and remodeling requirements.

D. Provide and install two system pumps of capacity and head scheduled on the drawings; one for continuous operation with the other on standby.

E. Hose Kits:

1. All units 120,000 BTUH and below shall be connected with hoses. The hoses shall be two (2) feet long, metal braided and fire rated to meet UL 94. Non fire rated hoses are not acceptable. The hose on the supply side of the unit will be complete with a ball valve and strainer. The hose on the return side will be complete with a ball valve and flow control valve that encompasses in one assembly an automatic flow control valve that will guarantee the specified flow rate plus or minus 5% over a wide press differential without having any external adjustments. The hose kit and flow control assembly shall be Griswold or Autoflow.

F. Provide PVC hose or insulated copper condensate connection of each air conditioner to pitched condensate drain system. Connect copper to unit with flexible connection.

G. Provide water makeup expansion tank, air separator, etc., as shown in Contact Documents.

2.4 CONTROLS

A. Manufacturer of electro-hydronic system components shall furnish the minimum list of system operating and safety controls.

B. System Safety and Operating Controls:
1. Solid-state components
2. Factory-mounted and wired within a NEMA 1 enclosure with a locking front panel.
3. Controls will monitor the system water loop and protect against malfunction, requiring field installation of just one temperature sensor plus a flow switch.
4. The panel shall include:
   a. Indicator lights
   b. Temperature gage
   c. Control relays
   d. Alarm with silencer switch
   e. Terminal board for convenient connection of all field wiring

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Complete system shall be installed in accordance with manufacturer's approved instructions and shall be equipped with necessary system operating and safety controls as detailed elsewhere in these specifications.

B. It is ESSENTIAL that the finished piping system be thoroughly flushed free of foreign material and construction debris.
1. Install strainer in system line at pump section.
2. Flush system prior to final connection to any electro-hydronic conditioner by means of loop bypass between supply to return at each unit location.
3. The hoses for final connection may first be used for the loop bypass.

C. Provide factory start-up of each heat pump and factory system operation check out of complete system.

END OF SECTION 232200

SECTION 23 2500 – CHEMICAL WATER TREATMENT

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. Procure services of Water Treatment Service Organization which will:
   1. Furnish and install required chemical feeding equipment and perform other related services as described in Contract Documents.
   2. Perform initial cleaning and flushing procedures.
   3. Provide chemicals required for cleaning and flushing systems.

B. Related Work Specified Elsewhere:
   1. Owner will supply operating chemicals after start-up chemicals have been exhausted.

1.3 SUBMITTALS

A. Quality Control:
   1. Submit written recommended treatment procedures, chemicals, chemical feeding equipment, and basic water analyses test equipment, based on its experience and chemical analysis of representative sample of water supply.

1.4 MAINTENANCE

A. Test Equipment:
   1. Provide water analysis test kit and adequate supply of reagents suitable to control treatment chemical dosage requirements.

PART 2 - PRODUCTS

2.1 HOT WATER SYSTEMS

A. Two Gallon bypass feeder complete, including piping, valves, and accessories.
   1. Provide adequate supply of Dearborn Aqua-Serv B-547 liquid borate-nitrite based corrosion inhibitor.

B. Approved Manufacturers:
   1. M. A. Fleckenstein
   2. Neptune
   3. Wingert

2.2 COOLING TOWER SYSTEM

A. Furnish and install a complete power pumped chemical feed system with water sensor, automatic control, feeder pump and 50 gallons of recommended chemical for use.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide initial start up and adjustment of all chemical systems.

B. Provide instruction to owner in the use and operation of the test kit.

C. Provide (2) two additional trips to the site during the warrantee period to check and adjust the chemical treatment system.

END OF SECTION 232500

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 MOTORIZED OUTSIDE AIR DAMPERS

A. Damper Blades:
   1. 18 gauge galvanized steel or equivalent aluminum with replaceable rubber blade edges, 9 inches wide maximum.
   2. End seals shall be flexible metal compression type.
   3. Opposed blade type.

B. Make provision for damper actuators and actuator linkages to be mounted external of air flow.

C. Approved Manufacturers & Models:

1. Air Balance - AC-2
2. American Warming - VC-2-AAVA
3. Arrow - OBDAF-207
4. Greenheck - VCD-2100
5. Honeywell - D641
6. Johnson - D1300
7. Louvers & Dampers - TSD400
8. Ruskin - CD36 or CD60
9. Safe Air - 610
10. Vent Products - 5800

2.8 BACKDRAFT DAMPER

A. Backdraft blades shall be nonmetallic and shall be neoprene coated fiberglass.

B. Stop shall be galvanized steel screen or expanded metal, 1/2 inch mesh.

C. Frame shall be galvanized steel or extruded aluminum alloy.

D. Approved Models & Manufacturers:
1. Air Control Products - FBD
2. American Warming - BD-15
3. CESCO - FBD 101
4. Ruskin - NMS2
5. Safe Air

2.9 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.

2.10 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 233114

SECTION 23 3318 - SMOKE DETECTORS

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. Ionization smoke detector mounted in supply air streams or as shown on drawings. Detector to operate on 120 volts AC.

PART 2 - PRODUCTS

2.1 SMOKE DETECTORS

A. Approved Manufacturers & Models:
   1. Series 2650-450 ionization type, duct mounted smoke detector, by Robertshaw
   2. MS Series ionization type duct mounted smoke detector by Air Products Controls Ltd.
   3. Model DH400 ACDC duct mounted smoke detector by System Sensor, a Division of Pittway
   4. Model 0550 duct smoke detector by Maple Chase Co.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install on systems greater than 2000 CFM and interlock with motor control to shut down fan systems upon smoke detection.

B. Install as shown on drawings at each smoke/fire damper location and connect to damper. Provide access door as specified in Section 23 3114. Smoke detectors to be installed within 5' of fire/smoke damper.

END OF SECTION 233318

SECTION 23 3346 - FLEX DUCT

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 supply air branch duct runouts to diffusers as described in Contract Documents.

PART 2 - PRODUCTS

2.1 DUCTS

A. Formable, flexible, circular duct which shall retain its cross-section, shape, rigidity, and shall not restrict air flow after bending.

B. Nominal 1-1/2 inches thick, 3/4 lb/cu ft density fiberglass insulation with air-tight, polyehtylene or polyester core, sheathed in seamless vapor barrier jacket factory installed over flexible assembly.

C. Assembly, including insulation and vapor barrier, shall meet Class I requirement of NFPA 90A and be UL 181 rated, with flame spread of 25 or less and smoke developed rating of 50 or under.

D. Length of flexible ductwork shall not exceed 8'-0".

2.2 APPROVED MANUFACTURERS

A. ANCO-FLEX - 4625

B. Flex-Aire - PF/UPC #090

C. Hart & Cooley - F114

D. Thermaflex - G-KM

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct in fully extended condition free of sags and kinks.

B. Make duct connections by coating exterior of duct collar for 3 inches with duct sealer and securing duct in place over sheet metal collar with 1/2 inch wide metal cinch bands and sheet metal screws.

END OF SECTION 233346

SECTION 23 3400 - EXHAUST FANS

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 exhaust fans as described in Contract Documents.

1.3 QUALITY ASSURANCES

A. Requirements of Regulatory Agencies:
   1. Bear AMCA seal and UL label.

PART 2 - PRODUCTS

2.1 CEILING MOUNTED EXHAUST FANS

A. Acoustically insulated housings.

B. Sound level rating of 4.6 sones maximum for fan RPM and CFM listed on Drawings.

C. Include chatterproof integral back-draft damper with no metal to metal contact.

D. True centrifugal wheels.

E. Entire fan, motor, and wheel assembly shall be easily removable without disturbing housing.

F. Suitably ground motors and mount on rubber-in shear vibration isolators.

G. Provide wall or roof cap, as required.

H. Approved Manufacturers:
   1. Cook-Gemini
   2. Greenheck Sp
   3. Pace
   4. Penn Zephyr

2.2 ROOF MOUNTED EXHAUST FANS

A. Direct drive or have adjustable pitch V-belt as noted on Drawings.

B. Wheels shall be backward curved and housing shall be removable or hinged aluminum.

C. Isolate motor with vibration dampeners.

D. Provide quiet type back-draft dampers.

E. Insulated, pre-fabricated metal roof curb shall be for flat or sloped roof as shown on Drawings.

F. Approved Manufacturers:
   1. Fans:
      a. Penn
      b. Centri-Master
      c. Cook
      d. Greenheck G, GB
   2. Standard curbs:
      a. Penn

b. Cook
c. Greenheck

3. Sound attenuating curbs:
   a. Penn
   b. Greenheck

2.3 CENTRIFUGAL IN-LINE FANS

A. Non-overloading design and of arrangement indicated.

B. Constructed of low carbon steel and painted with an approved rust resistant coating or all aluminum as shown.

C. Fan performance shall be based on tests conducted in accordance with the AMCA Standard test code of air moving devices and shall be licensed to bear the AMCA Certified Air and Sound Rating Seal. Fans shall have a sharply rising pressure characteristic extending through the operating range and continuing to rise well beyond the efficiency peak to assure quiet and stable operation under all conditions. Horsepower characteristics shall be truly self-limiting and shall reach a peak in the normal selection area.

D. Wheel diameters shall be in accordance with the standard sizes adopted by AMCA for centrifugal in-line type fans. Inlets shall be fully streamlined and housings shall be suitably braced to prevent vibration or pulsation. Housings shall be arc welded steel throughout.

E. Fan wheel shall include die formed AIRFOIL blades designed for maximum efficiency and quiet operation. Blades shall be continuously welded to back plate and welded to wheel cone. Class 2 fan with inlet and outlet bell fittings.

F. Wheels shall be statically and dynamically balanced and assembled fan shall be tested for balance at specified speed at the factory prior to shipment. Such tests shall be performed with an IRD analyzer to measure radial and axial displacements.

G. Bearings are to be ball or roller anti-friction type, and shall be equipped with extended lubrication lines to grease fittings outside of the fan housing. Shafts shall operate at no more than 70% of first critical speed to assure smooth operation.

H. Accessories for in-line fans to include belt guard, inlet and outlet flanges, and other accessories as called for in the plans.

I. All fans shall be equipped with an adjustable motor base integral with the fan housing. This motor base shall be completely welded and consist of frame and reinforcing side sheets to assure maximum strength and rigidity.

J. Submittals for approval of equipment shall include copies of outline drawings, AMCA Certified Sound Ratings, and percentage pressure-volume performance curves showing point of operation.

K. Approved Manufacturers:
   1. Barry
   2. Cook
   3. Penn

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor fan units securely to structure or curb.

END OF SECTION 233400

SECTION 23 3713 - AIR OUTLETS & INLETS

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 wall supply registers, transfer grilles, return air grilles, soffit grilles, ceiling diffusers, louvers connected to ductwork, and registers as described in Contract Documents.

PART 2 - PRODUCTS

2.1 GRILLES & REGISTERS

A. Approved Manufacturers:
   1. Price
   2. Anemostat
   3. Krueger
   4. Titus
   5. Tuttle & Bailey

2.2 SPIN-IN FITTINGS

A. Low pressure round take-offs to diffusers shall be made with spin-in fittings. They shall incorporate a manual balancing damper. The damper shall be spring loaded and a positive locking wing nut shall secure the damper position.

B. Approved Manufacturers:
   1. Sheet metal fittings: Genflex DB-1DEL, Hercules

2.3 LOUVERS

A. Extruded aluminum, with blades welded or screwed into frames and 1/2 inch mesh 16 gauge aluminum bird screen.

B. Frames shall have mitered corners.

C. Louvers shall be recessed, flanged, stationary, or removable as noted on Drawings.

D. Approved Manufacturers:
   1. Airolite
   2. American Warming
   3. Arrow
   4. Industrial Louvers
   5. Ruskin
   6. Vent Products

2.4 ROOF MOUNTED INLETS AND OUTLETS

A. FABRICATION
   1. Penthouse type of extruded aluminum complete with roof curb to fit slope of roof and ½ inch mesh 16 gauge aluminum bird screen.

B. APPROVED MANUFACTURERS & MODELS
   1. Tiered Type:
      a. Model TRE extruded aluminum ventilator by Loren Cook Company, Springfield Missouri
   2. Louvered Penthouse
      a. Penn “Penhouse”
      b. Model WRH by Greenheck Fan Corporation, Schofield, WI
      c. Model MPH by Jenn-Air Industries Inc., Indianapolis, IN

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor securely into openings.

B. Install with screws to match color and finish of grilles and registers.

C. Touch-up any scratched finish surfaces.

D. Install in accordance with manufacturer's instructions.

E. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

F. Install diffusers to ductwork with air tight connection.

G. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

H. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9000.

END OF SECTION 233713

SECTION 23 3813 – KITCHEN HOOD

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 kitchen hood as described in Contract Documents.

B. Servicing disconnect, final connection and reconnection of shipping joints is by electrical contractor.

1.3 QUALITY ASSURANCE

A. Canopy is to be listed by Underwriter's Laboratories, Inc. as "self-contained automatic damper and hood assembly for restaurant cooking appliance."

B. Canopy is to comply with requirements of NFPA Bulletin #96, NSF and requirements of local authority having jurisdiction.

C. Fire extinguishing system and canopy is to comply with all applicable sections of NFPA #17 and #96.

D. Light fixtures to be U.L. listed specifically for use in commercial kitchen exhaust canopies and to comply with the requirements of the National Electrical Code.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Canopy is to be sized as shown on the drawings.

B. Canopy interior is to be fabricated of #18 ga. S/S where exposed, and enclosed by an integral makeup air shell fabricated of #18 ga. S/S where exposed.

C. Makeup air shell fitted with perforated SS face.

D. Full compliment of U.L. classified, accessible, S/S removable grease extractor. Provide proper S/S spacers and integral pitched gutter with removable cup located beneath baffle row.

E. Vapor proof incandescent light fixtures on maximum 4'-0" centers factory installed and wired to junction box on top of canopy. All wiring to be outside the grease areas of exhaust canopy.

F. Each canopy to be fitted with exhaust collars and supply collars. Exhaust collars to be fitted with U.L. listed fire damper assemblies.

G. Top of makeup air shell fitted with anchors for 1/2" threaded rods. Hanger rods are furnished by installing contractor. Provide offset wall clip at rear for mounting.

H. Factory installed liquid Ansul R-102 chemical fire suppression system providing surface, duct and plenum protection. System to consist of chemical tank mounted at location approved by local authorities as high up as possible to allow head clearance. System is to include all necessary interconnecting piping and cable runs between the nozzles, fusible links, gas valve, manual release, and the location of the chemical cylinder. Install, where directed by local authorities, a remote manual release station. All exposed piping to be chrome plated or S/S jacketed.

I. Micro-switch in chemical tank for shutoff of electric heated cooking appliances. Power shutdown devices and interwiring of same are by the electrical contractor. Electrical contractor to verify with local authorities the items of equipment requiring power shutdown. Provide gas shutoff valve for shutoff of all gas fired cooking appliances. Valve furnished loose to plumbing contractor for installation by him into incoming gas line. This contractor is to co-ordinate valve size and location with plumbing contractor.

J. Ductwork to canopy shall consist of roof curb, roof top plenum assembly, inlet duct, and interwiring between exhaust fan, makeup air unit and central panel on wall. Roof curb fabricated of heavy gauge galvanized steel 8" high with welded corners and insulated with 1 1/2" fiberglass. Size to suit plenum assembly. Supply ductwork fabricated of #18 ga. galvanized steel, lined with 1/2" coated fiberglass. Finish exterior ductwork in grey enamel. Exhaust duct shall be fabricated of #16 ga. galvanized steel with all seams welded with a continuous external weld. Exhaust duct sized to provide 1500 FPM minimum velocity.

K. Ventilator control panel for wall mounting with switches and indicator lights for system "on-off" and heat "on-off" functions, control dial for varying discharge air temperature and switch for hood light fixture.

L. Necessary motor overload controls and starters for exhaust and supply fans, fully wired into systems. All controls mounted within rain tight cabinet.

M. Approved Manufacturers:
1. Greenheck
2. Econ-Air
3. K-Tech
4. Captive Air

PART 3 - EXECUTION

3.1 FIELD QUALITY ASSURANCE

A. Fire Extinguishing system and canopy is to be installed in full compliance with requirements of local authority having jurisdiction.

B. Job site work shall be performed by or under the supervision of a qualified factory authorized Ansul dealer.

C. Contractor to co-ordinate with architect and/or general contractor to determine exact placement of roof curb to avoid or adapt to physical obstructions and conditions.

D. Canopy manufacturer shall dispatch a factory trained technician to the job site to start-up, adjust and balance system. He shall instruct the owner's agent in the care, operation and maintenance of the system.

E. Type I Hood shall be installed with a clearance to combustibles of not less than 18″, that is, unless the gypsum wallboard or ½” thick or thicker cementitious wallboard attached to noncombustible structures is provided with a smooth, cleanable, nonabsorbent and noncombustible material installed between the hood and the gypsum or cementitious wallboard over an area extending not less than 18 inches in all directions from the hood.

END OF SECTION 233813

SECTION 23 3815 – KITCHEN HOOD MAKE-UP AIR UNIT AND EXHAUST FAN

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 make-up air unit and exhaust fan as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Arranged to supply 100% outside air and have capability of raising air temperature a minimum of 65 deg. F.

B. Direct gas fired with direct spark igniter and flame sensing rod. Combustion efficiency shall provide discharge air with an average concentration of less than 5 PPM of carbon monoxide.

C. Makeup air unit with intake hood, filter section, cleanable filters, automatic outside air damper and mounting base.

D. Necessary controls to monitor discharge temperature via a hood mounted dial control. Packaged wiring between hood and make-up air unit shall be provided.

E. Unit fan and heat "off-on" shall be provided by switches with appropriate indicator lights mounted in ventilator control cabinet.

F. Unit to be provided with contactors and proper motor protection and disconnects with single point electrical connection for the control of both exhaust and supply fans.

G. Designed for outdoor operation, with hinged panels for easy servicing access to motor, drive, burners and control without the use of tools. Provide insulated cabinet with metal on heated air side.

H. Supplied with a wide range burner having a modulating turndown ration of 30 to 1. Adjustable profile base plates shall be located upstream from blower and provided and sized to maintain the required velocity across the line burner. The burner assembly and gas manifold shall be completely prepiped and factory tested prior to shipment and controlled by a maxitrol modulating system.

I. Exhaust fan:
   1. Spun aluminum upblast type
   2. UL rated for kitchen hood exhaust
   3. Adjustable belt drive
   4. Non-overloading wheel
   5. Motor is to be mounted outside exhaust airstream in a ventilated motor compartment.

J. Approved Manufacturers:
   1. Greenheck
   2. Gaylord
   3. Reznor

PART 3 - EXECUTION

3.1 INSTALLATION

A. Unit to set upon one piece combination roof curb provided by equipment contractor to handle both the make-up air heater and the exhaust fan.

END OF SECTION 233815

SECTION 23 4100 – DISPOSABLE FILTERS

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 filters used in mechanical equipment.

PART 2 - PRODUCTS

2.1 HEAT PUMP FILTERS

A. Filters shall be two inch thick throw-away type as recommended by Heat Pump Manufacturer.

B. Build custom filter rack to adapt to standard size filters. Entire building heat-pumps to have no more than 3 filter sizes.

C. Provide two complete sets of extra filters for all heat pumps at project completion.

END OF SECTION 234100

SECTION 23 5134 – FLUES

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 flues as described in Contract Documents.

PART 2 - PRODUCTS

2.1 FLUES

A. Sections shall be UL listed.

B. Sections shall have:
1. Outer jacket of aluminum-coated or galvanized steel.
2. One inch minimum insulating air space.
3. Inner gas carrying pipe of stainless steel.
4. Capability of handling flue gas temperatures up to 1400 deg F on continuous basis.

C. Furnish items which form part of assembly including but not limited to:
1. Bracing and supports as recommended by Flue Manufacturer.
2. Cleanout sections
3. T-sections
4. Necessary straight sections
5. Ventilated roof thimble
6. Flashing and counterflashing
7. 'Backdraft preventer' installed at top of water heater and boiler flues.

D. Approved Manufacturers:
1. Metalbestos Model PS
2. Metivent Model GTD
3. Metal-Fab Inc All Fuel Chimney

2.2 VENT CAPS

A. Non-backdraft type.

B. Approved Manufacturers:
1. Ameri-cap
2. Breidert Type L
3. Triangle AFL
4. Acme Mastervent Type MVR.
5. Dura-Vent

END OF SECTION 235134

SECTION 23 5230 – GAS BOILER (FULTON)

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 Natural Gas Fired Fulton Pulse Combustion Hot Water Boiler or approved equal.

B. Each unit shall be pulse combustion type complete with boiler fittings and automatic controls. The boiler, with all piping and wiring, shall be completely factory assembled with stainless steel combustion chamber as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with maximum water working pressure of 100 psi. Boiler shall also comply to CSD-1 Code requirements.

C. Boiler shall be Firetube design, utilizing the principles of sealed combustion and fully condensing. The boiler, due to the nature of Pulse Combustion, shall be self aspirating requiring no forced or induced draft fan to supply air for combustion after ignition. Adequate openings shall be provided for access to the water side of the boiler. The boiler pressure vessel shall be completely insulated 2" minimum and encased in an 18 gauge metal cabinet with primer and finish coat of paint.

D. The Fulton Pulse Combustion Boiler shall be AGAL Approved as a Direct Vent Boiler. Conventional chimney or stack is not required. The direct venting shall be in accordance with the Product Data Submittal Sheet. The boiler shall have the combustion air intake supply ducted in from the outside. This air intake supply ductwork shall also be in accordance with the Product Data Submittal Sheet.

1.3 BOILER FITTINGS

A. Safety Valves shall be ASME Section IV and NBIC approved side outlet type. Their size and number shall be in accordance with Code requirements. Valves shall bear NBIC registration number.

B. Temperature and pressure gauge shall be mounted on top of boiler.

1.4 PULSE COMBUSTOR EQUIPMENT

A. The pulse combustor location shall be such that all combustor assembly components are located within water backed areas. Pulse combustion controls shall be of on/off operative type and are to include:
   1. Operating Temperature Controller for automatic start and stop of the pulse combustor.
   2. High Limit Temperature Controller (Manual Reset).
   3. One Low Water Cutoff Probe in boiler shell.
   4. Air Safety Switch to prevent operation until sufficient prepurge air is assured.
   5. An electronic type microprocessor based Combustion Flame Safeguard, specifically designed for Pulse Combustors to provide full protection against flame failures.
   6. Blocked Combustor Air Intake Switch for shut-down of unit (manual reset).
   7. Diagnostic control module

B. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls; and also located to prevent possible damage by water, fuel, or heat of combustion gases. All controls shall be mounted and wired according to AGA requirements. Electric current supply 120 volts, 60 cycle single phase.

1.5 OPERATING MANUAL

A. Instructions for installation, operation, and maintenance of the boiler shall be contained in a manual provided with each boiler unit.

B. A wiring diagram corresponding to the boiler shall be affixed to the control box cover.

1.6 START-UP

A. Boiler shall be checked out and started up by a factory trained service technician. Provide complete start-up sheets and efficiency data in the M & O manuals. A copy of this report shall be filed with the Division of Building Safety.

B. After installation, all boilers and pressure vessels shall be inspected by a State Commissioned Boiler Inspector and receive a certificate to operate. No boiler shall be put into service without this certificate.

END OF SECTION 235230

SECTION 23 5533 - UNIT HEATERS

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 05 00 apply to this Section.

1.2 SUMMARY

A. Furnish and install unit heaters as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Heavy steel casings with reinforcement ribs, rounded corners, fan venturi and threaded hanger brackets. Metal shall be treated to prevent rusting and shall be finished in baked enamel.

B. Condensers shall be serpentine or circular design with horizontal tubes, vertical fins and center supply and return connections on top and bottom of unit.
   1. Tubes shall be copper with aluminum fins mechanically bonded and brazed joints.
   2. Tubes shall have individual expansion bends and be rated for 150 psi and 375 deg. F.

C. Fans shall be aluminum secured to a steel hub and direct drive from motor shaft complete with fan guard and outlet deflectors.

D. Approved Manufacturers:
   1. Modine
   2. Or approved equal

END OF SECTION 235533

SECTION 23 5719 – PLATE AND FRAME HEAT EXCHANGERS

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 heat exchanger as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Construction shall conform to latest ASME Code for unfired pressure vessels.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Plate type heat exchangers with maximum pressure drop through heat exchanger of 5 psi.

B. Framework, pressure plate and fixed plate shall be of heavy carbon steel painted with epoxy enamel.

C. The heat exchanger corrugated channel plates shall be Type 304 stainless steel with nitrile gaskets. The gasket pattern on each channel plate distributes the fluid flow to alternate plate flow channels in the plate pack creating 100% counterflow resulting in high transfer effectiveness.

D. Approved Manufacturers:
   1. Bell & Gossett
   2. Alfa-Laval

END OF SECTION 235719

SECTION 23 5720 - ENERGY RECOVERY VENTILATORS

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 energy recover ventilator unit as described in Contract Documents.

1.3 SUBMITTALS

A. Energy Efficiency:
   1. Indicate Energy Efficiency Rating (EER) for equipment provided under work of this section
   2. Submit documentation for Energy Star qualifications for equipment provided under work of this Section.

B. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.

C. Reports for aquatic toxicity testing of lubricants in accordance with ASTM D6081.

1.4 QUALITY ASSURANCE

A. Energy Efficiency: Meet or exceed ASHRAE 90.1.

B. Indoor Environmental Quality:
   1. Ventilation: Meet or exceed ASHRAE 62 and all published addenda.
   2. Filtration: Meet or exceed ASHRAE 52.
   3. Thermal Comfort: Meet or exceed ASHRAE 55.
   4. Maintain positive pressure within the building.

PART 2 - DESCRIPTION

2.1 SYSTEM DESCRIPTION

A. Units capable of transferring sensible energy as listed to the equipment schedule.

B. Flat plate heat exchanger to be factory installed in unit.

C. Unit is designed to be used as a stand-alone heat recovery ventilator or as a heat recovery component in a dedicated HVAC system or as a complete ventilation HVAC unit.

2.2 QUALITY ASSURANCE

A. Unit shall be constructed in accordance with CSA C22.2 and UL 1812 and shall carry the (C)UL or (C) ETL label of approval.

B. Insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.

C. Airflow data shall comply with AMCA 210 method of testing.

2.3 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be stored and handled per unit manufacturer’s recommendations.

2.4 WARRANTY

A. Unit shall have a 2 year warranty on all parts not including flat plate heat exchanger.

B. Flat plate heat exchanger shall have a 15 year warranty.

C. Manufacturers without a 15 year warranty shall supply an extra flat plate heat exchanger for the entire unit. Plat plate heat exchanger to be turned over to the Owner at the time of delivery for stocking purposes.

PART 3 - PRODUCTS

3.1 EQUIPMENT

A. General
1. Packaged, heat recover ventilator consisting of flat plate heat exchanger, ventilation air fan, exhaust air fan, necessary dampers, temperature sensors, and microprocessor controls.

B. Unit Cabinet
1. Cabinet shall be constructed of 20 gauge G-90 galvanized steel with 12 or 16 gauge galvanized frame.

C. Access
1. Access to all components that require servicing shall be provided through sealed and easily removable access panels(s).
2. Flat plate heat exchanger shall be easily removable from the unit.
3. All parts must be serviceable in less than 7 minutes.

D. Flat Plate Heat Exchanger
1. Aluminum flat plate heat exchanger designed to meet NFPA 90A requirements for smoke development and flame spread.
2. Energy recovery effectiveness values shall be tested in accordance with ASHRAE 84 and ARI Standard 1060.

E. Operating Characteristics
1. Unit shall be capable of providing a constant volume of air at a specified external static pressure at all fan operating speeds.

F. Blowers
1. Fan ratings are based on tests made in accordance with AMCA Standard 210.
2. Blowers must be selected to operate on a stable efficient part of the fan curve when delivering air quantities scheduled against static of the system.
3. Fan blades shall be statically and dynamically balanced and tested prior to shipment.
4. Fan shall be provided with internal vibration isolation mounts.
5. Fan discharge shall be as noted on the plans.
6. Fans shall have sealed ball bearings with L10 life expectancy for belt drive units.

G. Motors
1. Motors shall be continuous duty, permanently lubricated, and matched to the fan loads.
2. Motors shall meet new EPAC regulations for efficiency and shall have inverter spike resistance wire for protection.
3. Motor selection must include a 15% service factor.

H. Electrical Requirements
1. Units shall have single point power connection only.
2. All controls shall be factory mounted and wired, requiring only field installation of remote sensing devices and wiring to unit mounted terminal strips.

I. Filters
1. Toxicity/IEQ: Provide filtration media with a Minimum Efficiency Reporting Value (MERV) of 13 as determined by ASHRAE 52.2. Coordinate with work of Section 01352 - IAQ Management.
2. Biobased Content: Minimum 95 percent biobased material.

3.2 CONTROLS

A. General
1. Unit shall be provided with a factory mounted and factory wired microprocessor control.
2. All service connectors shall be quick disconnect type.
3. Unit circuitry shall allow the following operational characteristics:
   a. Dry contacts for occupancy control
   b. Remote fan interlock on call for ventilation

c. Selection of low or high speeds
d. Remote wall control contacts
e. Unoccupied recirc contacts

3.3 OPTIONS

A. Defrost
1. Damper/Recirculation Defrost Cycle - unit shall be equipped with recirculation defrost from forming on the flat plate heat exchanger and prevent negative pressure from occurring in building envelope.

B. Double Wall Construction
1. Cabinet shall be insulated throughout and lined with a 26 gauge galvanized wall for easy cleaning, prevention of potential for microbial growth, and elimination of potential puncture of insulation membrane.

C. Pre-paint Cabinet
1. Unit cabinet shall be minimum 20 gauge pre-painted galvanized steel.

D. Access Panels
1. Unit shall have quick opening type fasteners to allow for easy access.

3.4 ACCESSORIES

A. Night Set Back
1. 24 hour programmable timer shall be included for occupied/unoccupied time settings.

B. CO_2 Controller
1. Non-dispersed infra-red control shall be provided to trigger ventilation at levels above 1000 ppm of CO_2

3.5 ACCEPTABLE MANUFACTURERS

A. Venmar

B. Renewaire.

C. Greenheck

D. Semco

PART 4 - EXECUTION

4.1 FILTERS

A. Provide one extra set of filters.

END OF SECTION 235720

SECTION 23 5721 - RADIANT SNOWMELT

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.

B. Examine all other portions of the contract documents for work or other terms and conditions related to the work of this section. Provide all work here under, as required for the support and accommodation of related work.

1.2 SUMMARY

A. All labor, materials, transportation, equipment and services to install hydronic radiant heating system where indicated on drawings supplied for the project.

PART 2 - PRODUCTS

2.1 SHOP DRAWINGS

A. Shop drawings, or descriptions of materials, and details of installation shall be submitted for approval as specified under TERMS AND CONDITIONS of contract document. No fabrication shall be performed until approval is obtained.

2.2 ALL COMPONENTS

A. Components of the buried tubing system shall be provided by one manufacturer, including: tube, fittings, manifolds, and other ancillary items required for a complete installation, as manufactured by Wirsbo Company, REHAU or approved equal.

2.3 WARRANTY

A. Tube shall carry a twenty (20) year non-prorated warranty against failure due to defect in material and workmanship. Manifolds and other ancillary components shall be warranted for eighteen (18) months from date of shipment.

2.4 MATERIALS

A. Tube:
   1. Tube shall be cross-linked polyethylene, with maximum working pressure/temperature of 100 psi @ 180°F. These temperatures and pressure ratings shall be issued by hydrostatic stress board of PPI (Plastic Pipe Institute). PPI is a division of SPI (Society of Plastics Industry).
   2. The tube shall be manufactured in accordance with ASTM standard specification F 876. The tube shall be listed to ASTM by independent third party testing laboratory.
   3. The tube shall be of cross-linked polyethylene manufactured by the "Engel Method." The tube shall have an oxygen diffusion barrier capable of limiting oxygen diffusion through the tube to no greater than .10g/m3 /day @ 104°F water temperature.
   4. The tube dimensions shall be:
      a. 3/4" nominal inside diameter (7/8" outside diameter), in accordance with ASTM standard specification, as above, or
      b. 5/8" nominal inside diameter (3/4" outside diameter), in accordance with ASTM standard specification, as above, or
      c. 1/2" nominal inside diameter (5/8" outside diameter), in accordance with ASTM standard specification, as above, or
      d. 3/8" nominal inside diameter (1/2" outside diameter), in accordance with ASTM standard specification, as above
   5. The minimum bend radius for cold bending of the tube shall not be less than six (6) times the outside diameter. Bends with a radius less than stated shall require the use of a bend support as supplied by the tube manufacturer.

B. Manifolds:
   1. Manifolds shall be of cast brass construction, manufactured of alloys to prevent dezincification, and shall have integral circuit balancing valves. Manifolds shall be able to vent air from the system, and shall be

provided with support brackets and tube bend supports. Manifolds shall be isolated from supply and return tubing with valves that are suitable for isolation and balancing.

C. Fittings:
1. Fittings shall be manufactured of dezincification resistant brass. These fittings must be supplied by the tube manufacturer. The fittings shall consist of a compression fitting with insert, compression ring and a compression nut.

D. Supply and return piping to manifolds:
1. Piping shall be metal pipe or cross-linked polyethylene tube with an integral oxygen diffusion barrier. Cross-linked polyethylene tube should only be used when specifically approved by the local building inspector for supply and return piping applications.
2. Fittings shall be compatible to the piping material used. Fittings used with the cross-linked polyethylene tube shall not permit excessive oxygen permeation.

E. Snow Detector and Melting Control 664, Pulse Width Modulation:
1. The system water temperature shall be based on the outdoor temperature and feedback from sensors located in the snow melting slabs.
2. The control shall have an adjustable minimum supply water temperature setting to help prevent condensation of the flue gases and subsequent corrosion and blockage of the boiler's heat exchanger and chimney.
3. The control shall have the option to directly operate a variable speed injection pump, a mixing valve with a floating action actuator motor, or a 4-20 mA device.
4. The control shall have the ability to limit the amount of cool water being returned to the boiler through the mixing device in order to prevent low boiler operating temperatures and flue gas condensation.
5. The control shall have the ability to directly control the supply temperature of one of two boiler stages or to send a boiler enable signal to another boiler operating control to allow for a staging control to be connected.
6. The control shall have the option of an automatic differential calculation for the operation of one or two boiler stages in order to prevent short cycling.
7. The control shall have an option to rotate the firing sequence of the boilers and the option for rotating the boiler firing sequence shall be based on the boilers' accumulated running hours.
8. The control shall use proportional, integral and derivative (PID) logic when staging boiler stages.
9. The control shall have four separate lockable access levels to limit the number of adjustments available to various users.
10. The control shall have a test button that activates a pre-programmed test sequence testing all of the control's outputs.
11. The control shall show a number of current sensor temperatures depending on the access level that has been selected.
12. The control shall continuously monitor its temperature sensors and provide an error message upon a control or sensor failure.
13. The control shall record and display various device running hours and minimum and maximum temperatures depending on the access level that has been selected.
14. During extended periods of inactivity, the pumps and valves that are operated by the control shall be periodically exercised to prevent seizure during long idle periods.
15. The control shall have the ability to operate two zones of snow melting.
16. The control shall have three levels of priority when operating two zones of snow melting.
17. The control shall have the ability to use a snow/ice sensor in order to automatically detect snow or ice and begin operation of the system. The system shall continue to run unit the sensor is dry or the control is manually stopped.
18. The control shall have the ability to be manually started with an adjustable running time that counts down and automatically stops the system.
19. The control shall have the option of connecting a remote display module to allow for remote monitoring and adjustment of the control.
20. The control shall have the option of connecting a remote start/stop module to allow for starting and stopping of the system.
21. The control shall not operate the system to provide heat to the snow melting zones when it enters into either a warm weather shut down (WWSD) or a cold weather cut off (CWCO) mode.
22. Approved Sensors:
    a. Outdoor Sensor 070.
    b. Snow/Ice Sensor 090, 65 foot Wire.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hydronic radiant heat tubing loops shall be installed in accordance with the manufacturer's recommendations and the details as shown on the contract drawings.

B. All fittings should be accessible for maintenance. Tubing loops shall be installed without splices, as a minimum, from the point at which the tubing enters the panel to the point at which it exits the panel.

C. Installation shall follow the shop drawings for tubing layout, tube spacing, manifold configuration, manifold location, and controls. All notes on the drawing shall be followed.

D. The tubing system shall be pressurized, with water or air, in accordance with applicable codes, or to a pressure of 60 psig 24 hours prior to encasement in the radiant panel. The tubing system shall remain at this pressure during the panel installation and for a minimum of 24 hours thereafter to ensure system integrity. The contractor shall provide the water or air for the pressurization of the tubing system. The contractor assumes all liabilities for suitable safety precautions and testing, including the use of compressed air, when applicable.

E. At start up time, the contractor shall: follow the manufacturer's recommendations for system water and temperature balancing, record balance settings at each manifold location, and deliver to the owner a complete record of these settings for inclusion in the operation and maintenance manuals.

END OF SECTION 238313

SECTION 23 6514 – COOLING TOWER

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 Cooling Tower, Water Treatment, Remote Sump and Tower Pump as described in Contract Documents.

PART 2 - PRODUCTS

2.1 COOLING TOWER

A. General:
   1. Fiberglass cooling tower.
   2. Unit shall be single cell, induced draft, vertical discharge, counter-flow design, utilizing fiberglass reinforced polyester (FRP) materials in basin and casing of cooling tower structure.
   3. Tower shall be supplied as a field erected package complete with assembly and necessary components and accessories as required for complete installation.

B. Cold Water Basin:
   1. Cooling tower basin shall be molded of corrosion-resistant fiberglass reinforced polyester (FRP) material to assure durability and long life.
   2. Basin shall be a multi-segment structure, equipped with provisions for connections to hot water inlet, cold water outlet, and basin drain for remote sump application.

C. Tower Casing:
   1. Cooling tower casing shall be molded of corrosion-resistant fiberglass reinforced polyester (FRP) material to assure durability and long life.
   2. Casing shall be a multi-segment type, providing easy access to the fill media.
   3. Casing panels shall be capable of withstanding wind loads of at least thirty (30) pounds per square foot.

D. Fans:
   1. Fan blades shall be slow speed, aerodynamically designed, propeller type with adjustable pitch to provide efficient use of power and to assure quiet operation.
   2. Fan blades and related hub shall be constructed of a special cast aluminum alloy material for corrosion-resistance and maintenance free operation.

E. Fan Motor/Drive System:
   1. Multi-blade propeller type fan blade shall be driven by a special V-belt reducer unit to provide proper speed and to assure constant air flow thru fill media.
   2. Reducer assembly shall have provisions for belt adjustment and related maintenance without disassembly of drive system.
   3. Fan motor shall be a single speed totally enclosed, air-over (TEAO), permanently lubricated, ball bearing type, with 1.15 service factor, suitable for outdoor service.
   4. Motor/V-belt reducer and fan assembly shall be supported on a structural steel support protected by hot-dip galvanized coating.
   5. Suitable fan guard shall be included.

F. Fill:
   1. Cooling tower fill shall be PVC (polyvinyl chloride) of corrugated and embossed design to provide maximum air to water contact for optimum heat transfer efficiency.
   2. Fill shall be provided in a circular configuration to enable easy replacement if required.
   3. The PVC material shall be fire resistant, and shall meet the provisions of ASTM Standard E-84 with a flame spread rate of 25.
   4. Fill must withstand a maximum water temperature of 130 deg. F. and be resistant to rot, decay, or biological attack.

G. Water Distribution: Water distribution shall be provided through a rotating sprinkler head system. Water from the

inlet connection shall be forced thru the rotating sprinkler system under pump pressure and distributed evenly over the entire fill area. The rotating sprinkler head and related piping shall be non-ferrous, non-corrosive and self-rotating at low head loss. All sprinkler pipes shall have removable end caps for maintenance purposes.

H. Eliminators: Special drift eliminators shall be attached to the sprinkler pipes to effectively reduce drift (carry-over) from the airstream. Drift loss shall be limited to 0.2 percent at design/operating conditions. Eliminators shall be of non-ferrous, non-corrosive materials.

I. Hardware & Finish: All metal fasteners (nuts, bolts, washers) shall be stainless steel to resist corrosion. All supporting steel structure shall be Stainless Steel.

J. All fiberglass reinforced polyester materials (FRP) shall contain UV (ultra-violet) inhibitors, fire retardant fillers to satisfy ASTM E-84-Class A and an exterior gel coat to protect the structural integrity of the basin and casing. Exterior surface shall have a cosmetically appealing surface that is durable, long lasting and eliminates the need for other finishing.

K. The tower will be provided with an OSHA approved ladder adequate to allow inspection and accessibility to the fan/motor and upper portion of the tower cell. In addition, a suitable wire-grill fan guard will be provided. These items shall be protected with a hot-dip galvanized coating.

L. Air inlet louvers of a PVC plastic material shall be provided to prevent objects from entering the water basin.

M. Color – Towers to be Gray or Tan Fiberglass – No Exceptions.

N. Approved Manufacturers:
1. AMCOT
2. Protec

O. Water Treatment:
1. Complete packaged water treatment system for the cooling tower.
2. Submit with cooling tower submittal.
3. Approved Manufacturers:
    a. Chemicator system by V.O.P. with six refill tubes.

2.2 REMOTE SUMP

A. Sumps shall be constructed of the following metal thickness.
1. Rectangular:
    a. Sides up to 5 feet wide x 6 feet tall shall be 3/16 inch plate steel.
    b. Sides larger than 5 feet wide or 6 feet tall shall be 1/4 inch plate steel.
2. Round:
    a. Up to 6 feet round x 6 feet high side and bottom shall be 3/16 inch plate steel rolled to diameter.
    b. Larger than 6 feet round or 6 feet high sides and bottom shall be 1/4 inch plate steel rolled to diameter.

B. All seams and fittings shall be welded inside and outside and be leak free. Heavy duty 3 inch angle iron shall be cut or rolled to fit top of tank and welded on top edge of tank for rigidity. Tank lids shall be the same thickness of material as the tank itself and shall extend to the outside edge of the 3 inch angle iron frame. Lids shall be cut in half and hinged with a heavy duty continuous hinge. The interior of the tank shall be coated with a 12 mill thickness of epoxy, manufactured specifically for water tanks. The exterior of the tank shall be coated the same as the interior if the tank is mounted above ground. If the tank is to be below grade, the exterior shall be coated with a 12 mill coating of a cold tar epoxy. The lid shall be coated the same as the interior of the tank. All coatings shall be applied after all welding is done to insure a complete coverage of all metal, welds, fittings, flanges, hinges, handles, etc.

C. All tanks shall be complete with a pedestal mounted float switch to sense low water, and a slow closing solenoid valve to automatically feed water when a low water condition is sensed.

END OF SECTION 236514

END OF DIVISION 23