

DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING

23 0000 HEATING, VENTILATING, AND AIR-CONDITIONING

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SECTION 23 0501 – COMMON HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Furnish labor, materials, and equipment necessary for completion of work as described in Contract Documents.
- B. It is the intent of these specifications that the systems specified herein are to be complete and operational before being turned over to the owner. During the bidding process, the contractor is to ask questions or call to the engineer's attention any items that are not shown or may be required to make the system complete and operational. Once the project is bid and the contractor has accepted the contract, it is his responsibility to furnish and install all equipment and parts necessary to provide a complete and operational system without additional cost to the owner.
- C. Furnish and install fire stopping materials to seal penetrations through fire rated structures and draft stops.
- D. Includes But Not Limited To:
 - 1. General procedures and requirements for HVAC.
- E. Related Sections:
 - 1. Section 23 0593: Testing, Adjusting, and Balancing for HVAC.

1.3 SUBMITTALS

- A. Substitutions: By specific designation and description, standards are established for specialties and equipment. Other makes of specialties and equipment of equal quality will be considered provided such proposed substitutions are submitted to the Architect for his approval, complete with specification data showing how it meets the specifications, at least 5 working days prior to bid opening. A list of approved substitutions will be published as an addendum.
 - 1. Submit a single copy of Manufacturer's catalog data including Manufacturer's complete specification for each proposed substitution.
 - 2. The Architect or Engineer is to be the sole judge as to the quality of any material offered as an equal.
- B. Product Data, Shop Drawings: Within 30 days after award of contract, submit 10 sets of Manufacturer's catalog data for each manufactured item.
 - 1. Literature shall include enough information to show complete compliance with Contract Document requirements.
 - 2. Mark literature to indicate specific item with applicable data underlined.
 - 3. Information shall include but not be limited to capacities, ratings, type of material used, guarantee, and such dimensions as are necessary to check space requirements.
 - 4. When accepted, submittal shall be an addition to Contract Documents and shall be in equal force. No variation shall be permitted.
 - 5. Even though the submittals have been accepted by the Engineer, it does not relieve the contractor from meeting all of the requirements of the plans and specifications and providing a complete and operational system.
- C. Drawings of Record: One complete sets of blue line mechanical drawings shall be provided for the purpose of showing a complete picture of the work as actually installed.
 - 1. These drawings shall serve as work progress report sheets. Contractor shall make notations neat and legible therein daily as the work proceeds.
 - 2. The drawings shall be kept at the job at a location designated by the Mechanical Engineer.
 - 3. At completion of the project these "as-built" drawings shall be signed by the Contractor, dated, and returned to the Architect.
- D. Operating Instructions and Service Manual: The Mechanical Contractor shall prepare 2 copies of an Operation and Maintenance Manual for all mechanical systems and equipment used in this project. Manuals shall be bound in hard-backed binders and the front cover and spine of each binder shall indicate the name and location of the project. Use plastic tab indexes for all sections. Provide a section for each different type of equipment item. The following items

shall be included in the manual, together with any other pertinent data. This list is not complete and is to be used as a guide.

1. Provide a master index at the beginning of the manual showing all items included.
 2. The first section of the manual shall contain:
 - a. Names, addresses, and telephone numbers of Architect, Mechanical Engineer, Electrical Engineer, General Contractor, Plumbing Contractor, Sheet Metal Contractor, and Temperature Control Contractor.
 - b. List of Suppliers which shall include a complete list of each piece of equipment used with the name, address, and telephone number of vendor.
 - c. General Description of Systems including –
 - 1) Location of all major equipment
 - 2) Description of the various mechanical systems
 - 3) Description of operation and control of the mechanical systems
 - 4) Suggested maintenance schedule
 - d. Copy of contractor's written warranty
 3. Provide a copy of approved submittal literature for each piece of equipment.
 4. Provide maintenance and operation literature published by the manufacturer for each piece of equipment which includes: oiling, lubrication and greasing data; belt sizes, types and lengths; wiring diagrams; step-by-step procedure to follow in putting each piece of mechanical equipment in operation.
 5. Include parts numbers of all replaceable items.
 6. Provide control diagram and operation sequence, along with labeling of control piping and instruments to match diagram.
 7. Include a valve chart indicating valve locations.
- E. Include air balance and/or water balance reports.

1.4 SUBMITTALS FOR COMMON HVAC REQUIREMENTS

- A. Samples: Sealer and gauze proposed for sealing ductwork.
- B. Quality Assurance / Control:
 1. Manufacturer's installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.
 2. Specification data on sealer and gauze proposed for sealing ductwork.
- C. Quality Assurance
 1. Requirements: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.
 2. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.

1.5 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
 1. Perform work in accordance with applicable provisions of local and state Plumbing Code, Gas Ordinances, and adoptions thereof. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
 2. In case of differences between building codes, state laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Architect in writing of such differences.
- B. Applicable Specifications: Referenced specifications, standards, and publications shall be of the issues in effect on date of Advertisement for Bid.
 1. "Heating, Ventilating and Air Conditioning Guide" published by the American Society of Heating and Air Conditioning Engineers.
 2. "Engineering Standards" published by the Heating, Piping, and Air Conditioning Contractors National Association.
 3. "2015 International Building Code", "2015 International Mechanical Code", "2015 International Plumbing Code" and "2015 International Fire Code" as published by the International Conference of Building Officials.
 4. "National Electrical Code" as published by the National Fire Protection Association.
 5. "2015 International Energy Conservation Code".
- C. Identification: Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when Project is turned over to Owner.

1.6 INSPECTIONS AND PERMITS

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

1.7 ADDITIONAL WORK:

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

PART 2 - PRODUCTS FOR COMMON HVAC REQUIREMENTS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Site Inspection:
 - 1. Examine premises and understand the conditions which may affect performance of work of this Division before submitting proposals for this work.
 - 2. No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
- B. Drawings:
 - 1. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc, and do not attempt to show complete details of building construction which affect installation. This Contractor shall refer to architectural, structural, and electrical drawings for additional building detail which affect installation of his work.
 - a. Follow mechanical drawings as closely as actual building construction and work of other trades will permit.
 - b. No extra payments will be allowed where piping and/or ductwork must be offset to avoid other work or where minor changes are necessary to facilitate installation.
 - c. Everything shown on the mechanical drawings shall be the responsibility of Mechanical Contractor unless specifically noted otherwise.
 - 2. Consider architectural and structural drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over mechanical drawings.
 - 3. Because of small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions. Do not scale drawings for locations of equipment or piping. Refer to large scale dimensioned drawings for exact locations.
- C. Insure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents.
 - 1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.
 - 2. If non-specified equipment is used and it will not fit job site conditions, this Contractor assumes responsibility for replacement with items named in Contract Documents.

3.2 PREPARATION

- A. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
 - 1. Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.

2. Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
3. Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

3.3 INSTALLATION

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

3.4 STORAGE AND PROTECTION OF MATERIALS:

- A. Provide storage space for storage of materials and assume complete responsibility for losses due to any cause whatsoever. Storage shall not interfere with traffic conditions in any public thoroughfare.
- B. Protect completed work, work underway, and materials against loss or damage.
- C. Close pipe openings with caps or plugs during installation. Cover fixtures and equipment and protect against dirt, or injury caused by water, chemical, or mechanical accident.

3.5 EXCAVATION AND BACKFILL

- A. Perform necessary excavation of whatever substance encountered for proper laying of all pipes and underground ducts.
 1. Excavated materials not required for fill shall be removed from site as directed by Engineer.
 2. Excavation shall be carried low enough to allow a minimum coverage over underground piping of 5'-0" or to be below local frost level.
 3. Excess excavation below required level shall be backfilled at Contractor's expense with earth, sand, or gravel as directed by Engineer. Tamp ground thoroughly.
 4. Ground adjacent to all excavations shall be graded to prevent water running into excavated areas.
- B. Backfill pipe trenches and allow for settlement.
 1. Backfill shall be mechanically compacted to same density as surrounding undisturbed earth.
 2. Cinders shall not be used in backfilling where steel or iron pipe is used.
 3. No backfilling shall be done until installation has been approved by the Engineer.

3.6 COOPERATION

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

3.7 SUPERVISION

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

3.8 INSTALLATION CHECK:

- A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule shall visit the project to inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the project as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.
- B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying the following:
 1. Equipment has been properly installed and lubricated.
 2. Equipment is in accurate alignment.
 3. Equipment is free from any undue stress imposed by connecting piping or anchor bolts.
 4. Equipment has been operated under full load conditions.
 5. Equipment operated satisfactorily.
- C. All costs for this installation check shall be included in the prices quoted by equipment suppliers.

3.9 CLEANING EQUIPMENT AND PREMISES

- A. Properly lubricate equipment before Owner's acceptance.
- B. Clean exposed piping, ductwork, equipment, and fixtures. Repair damaged finishes and leave everything in working order.
- C. Remove stickers from fixtures and adjust flush valves.
- D. At date of Substantial Completion, air filters shall be new, clean, and approved by Owner's representative.
- E. Trap elements shall be removed during cleaning and flushing period. Replace trap elements and adjust after cleaning and flushing period.

3.10 TESTS

- A. No piping work, fixtures, or equipment shall be concealed or covered until they have been inspected and approved by the inspector. Notify inspector when the work is ready for inspection.
- B. All work shall be completely installed, tested as required by Contract Documents and the city and county ordinances and shall be leak-tight before the inspection is requested.
- C. Tests shall be repeated to the satisfaction of those making the inspections.
- D. Water piping shall be flushed out, tested at 100 psi and left under pressure of supply main or a minimum of 40 psi for the balance of the construction period.

3.11 WARRANTY

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

3.12 SYSTEM START-UP, OWNER'S INSTRUCTIONS

- A. Off-Season Start-up
 - 1. If Substantial Completion inspection occurs during heating season, schedule spring start-up of cooling systems. If inspection occurs during cooling season, schedule autumn start-up for heating systems.
 - 2. Notify Owner 7 days minimum before scheduled start-up.
 - 3. Time will be allowed to completely service, test, check, and off-season start systems. During allowed time, train Owner's representatives in operation and maintenance of system.
 - 4. At end of off-season start-up, furnish Owner with letter confirming that above work has been satisfactorily completed.
- B. Owner's Instructions
 - 1. Instruct building maintenance personnel and Owner Representative in operation and maintenance of mechanical systems utilizing Operation & Maintenance Manual when so doing.
 - 2. Minimum instruction periods shall be as follows –
 - a. Mechanical - Four hours.
 - b. Temperature Control - Four hours.
 - c. Refrigeration - Two hours.
 - 3. Instruction periods shall occur after Substantial Completion inspection when systems are properly working and before final payment is made.
 - 4. None of these instructional periods shall overlap another.

3.13 PROTECTION

- A. Do not run heat pump, air handling units, fan coil units, or other pieces of equipment used for moving supply air without proper air filters installed properly in system.
- B. The mechanical systems are not designed to be used for temporary construction heat. If any equipment is to be started prior to testing and substantial completion, such equipment will be returned to new condition with full one year warranties, from date of substantial completion after any construction use. This includes, but is not necessarily limited to: Equipment, filters, ductwork, fixtures, etc.

3.14 COMMON HVAC REQUIREMENTS:

A. INSTALLATION

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

B. CLEANING

- 1. Clean interior of duct systems before final completion.

END OF SECTION 23 0501

SECTION 23 0502 - DEMOLITION AND REPAIR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DRAWINGS AND EXISTING CONDITIONS

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

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 TEMPORARY CONNECTIONS

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

3.2 EXISTING TO BE ABANDONED

- A. All required drilling, cutting, block-outs and demolition work required for the removal and/or installation of the mechanical system is the responsibility of this Contractor.
- B. No joists, beams, girders, trusses or columns shall be cut by any Contractor without written permission from the Architect.
- C. The patching, repair, and finishing to existing or new surfaces is the responsibility of this Contractor, unless specifically called for under sections of specifications covering these materials.
- D. Disconnect all equipment that is to be removed or relocated. Relocate any existing equipment that obstructs new construction.

3.3 EXISTING TO REMAIN IN USE

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

3.4 MATERIALS AND EQUIPMENT REMOVED

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

END OF SECTION 23 0502

SECTION 23 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. Steam Pipe, Hot, 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
STM	Steam Lines	Orange
COND	Steam Condensate Return Line	Lt Orange
NG	Natural Gas	Yellow

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

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

END OF SECTION 23 0553

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY SCOPE

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems.
 - a. Furnaces.
 - b. Air Handlers.
 - c. Exhaust Fans.

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 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.

3.3 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.

3.4 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.

3.5 DEMONSTRATION

- A. If requested, testing, adjusting, and balancing agency shall conduct any or all of the field tests in the presence of the engineer.
- B. Agency shall include a maximum of one (1) call back to the project within the one year warranty period to make additional adjustments if requested by the engineer.

END OF SECTION 23 0593

SECTION 23 0712 - MECHANICAL INSULATION AND FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Furnish and install mechanical insulation and fire stopping as described in Contract Documents including but not limited to the following:
 1. Ductwork Insulation
 2. Heating Piping Insulation
 3. Refrigerant Piping
 4. Fire Stopping

1.3 QUALITY ASSURANCE

- A. Insulation shall have composite (insulation, jacket or facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard ratings as tested by Procedure ASTM E-84, NFPA 255 and UL 723 not exceeding: Flame Spread of 25 and Smoke Developed of 50.
- B. Insulation Contractor shall certify in writing, prior to installation, that all products to be used will meet the above criteria.
- C. Accessories, such as adhesives, mastics, cements, and tapes, for fittings shall have the same component ratings as listed above.
- D. Products, or their shipping cartons, shall bear a label indicating that flame and smoke ratings do not exceed above requirements.
- E. Any treatment of jacket or facings to impart flame and smoke safety shall be permanent.
- F. The use of water-soluble treatments is prohibited.

END OF SECTION 23 0712

SECTION 23 0714 – PREMOLDED ONE PIECE PVC FITTINGS INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Approved Manufacturers:
 - 1. Zeston

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Where factory premolded one piece PVC insulating fitting covers are to be used, proper factory precut Hi-Lo Temp insulation 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 23 0714

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 23 0716

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 23 0717

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.
- B. Furnish and install lining in concrete underfloor boxes.

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. Certaineed 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 dishd 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 23 0718

SECTION 23 0768 - STEAM SUPPLY AND CONDENSATE RETURN PIPING 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 15055 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 -
 - 2. With hydraulic setting insulating cement, or equal, to thickness equal to adjoining pipe insulation.
 - 3. With segments of molded insulation securely wired in place.
 - 4. With prefabricated covers made from molded pipe insulation finished with vapor barrier adhesive.
 - 5. With Zeston covers and factory supplied insulation diapers.
 - 6. Finish fittings and valves with four ounce canvas and coat with vapor barrier adhesive or Zeston covers.

END OF SECTION 23 0768

SECTION 23 0800 – FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Material shall be flexible, long lasting, intumescent acrylic seal to accommodate vibration and building movement.
- B. Caulk simple penetrations with gaps of 1/4" or less with:
 - 1. Dow Corning Fire Stop Sealant
 - 2. Pensil 300
- C. Caulk multiple penetrations and/or penetrations with gaps in excess of 1/4" with:
 - 1. Dow Corning Fire Stop Foam
 - 2. Pensil 200
 - 3. IPC flame safe FS-1900
 - 4. Tremco "Tremstop 1A"

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow manufacturer's installation instructions explicitly.
- B. Seal penetrations of ductwork, piping, and other mechanical equipment through one-hour and two-hour rated partitions as shown on Architectural and Mechanical Drawings.
- C. Install fire stopping material on clean surfaces to assure adherence.

END OF SECTION 23 0800

SECTION 23 0950 – BUILDING AUTOMATION CONTROL SYSTEM

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 protocols 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 protocol 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 protocol. 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. jrnsford@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 device:
 - 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 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.

2.11 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.

2.12 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

2.13 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

2.14 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.

2.15 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 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.
- 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-coated 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 23 0950

SECTION 23 0953 – TEMPERATURE CONTROLS (DDC) (ALTERNATE)

PART 1 - SYSTEM OVERVIEW

A. DDC CONTROL SYSTEM

1 Statement of Intent

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.

2 Specification Compliance

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.

3 Approved DDC Contractor and System

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

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.

B. SCOPE OF WORK

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

4 Control Hardware and Software

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.

Specifically the ATC Contractor shall furnish the following:

a Individual unitary control modules for each unitary system:

Unit Ventilator
Cabinet Unit Heater
Air Handling Unit

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

None

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

OA Conditions

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

Heat Pump Isolation Valve and Actuator

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

None

f Required software integration to other digital control systems:

None

5 Control Wiring and Interface to Line Voltage Control

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.

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

6 Control Integration with Third Party Digital Controls Supplied by Others

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.

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.

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

Acceptable protocols:

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

7 Commissioning

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 performing 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.

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.

8 Training and Technical Support

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.

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.

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.

9 SUBMITTALS AND O&M MANUALS

a Submittals

Submittals shall include the following sections:

i Shop Drawings with:

- Title Page
- Table of Contents
- Typical Device Wiring Drawings
- Summary Bill of Materials
- Sequences of Operation
- Local Area Network Drawings
- Drawings for all operating systems showing both equipment and module connections
- Bill of Materials Specific to Each Drawing

ii Manufacturer's specification data sheets for all:

- control modules
- sensors
- dampers
- valves
- actuators
- flow switches
- current sensors
- transducers

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

b O&M Manuals

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.

10 SYSTEM SOFTWARE

System Software shall include the following:
DDC operating system

- Any software required for control logic programming
- Any software required for graphics generation
- Any other software used to create a fully functional system
- Site specific database

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

All licenses shall become the property of the Owner

PART 2 - CONTRACTOR CAPABILITY

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

PART 3 - HARDWARE

A SYSTEM SERVER

Merge new equipment into existing Automated Logic frontend server

B FIELD HARDWARE

- 1 BACnet

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

System shall observe the concept of distributed control. All modules shall have “stand alone” capability and shall maintain operator setpoints without connection to primary controllers or central station equipment. Modules shall be located at each operating equipment location such that individual systems or zones shall remain functional without communication to other systems on the network. Equipment operating logic, schedules and current trends shall reside in control modules serving each system. Use of global modules required to maintain programming, schedules or current trend data are not acceptable.

- 3 Ethernet Gateway Routers

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

- 4 Control Modules

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

- c All modules shall have battery backup capable of maintaining all programs, setpoints, schedules and trend information for a minimum of 7 days.
 - d 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.
 - e Control Modules shall communicate via BACnet over either:
 - i ARCnet at a speed of 156 kbaud
- 5 Temperature Sensors (analog)
- a Wall mounted zone temperature sensors shall be 10 k ohm thermistor.
 - i 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.
 - ii 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.
 - iii Gymnasium sensors shall also include a key access override feature.
 - b All other temperature sensors shall be industry standard thermistor or 4-20 milli-amp.
 - c 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.
 - d Immersion sensors shall be mounted in a blind well for future serviceability.
- 6 AHU Freeze Protection Thermostats (binary)
- a 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.
 - b 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.
 - c An auxiliary switch on the freeze protection shall be wired to the AHU control module for alarming and additional control actions.
- 7 Current Transformers
- a 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.
 - b 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.
 - c 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.
- 8 Pressure Sensors (analog)
- a 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.
 - b 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.
 - c 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.
- 9 Hi Pressure Safety (binary)
- a 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.
- 10 Valve and Damper Actuators
- a Actuators shall be manufactured by Belimo.
 - b Torque shall be rated 20% above required load.

- c 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.
- d 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.
- e Valve actuators used on any Heating Water Valve shall have spring return to open valve upon loss of power.
- f Valve actuators used on any Steam Valve shall have spring return to close valve on loss of power.

11 Dampers

- a 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.
- b When outside air intake dampers for economizers are furnished by ATC Contractor those dampers shall be opposed blade style.
- c Individual damper blades shall not exceed 48".

12 Wire

- a All wiring in open areas at heights below 12 feet must be run in conduit.
- b Control wiring may be run open in accessible ceiling or under floor areas.
- c Control wiring in non-accessible ceilings, walls or floors shall be in conduit.
- d All wiring not in conduit or control cabinets shall be rated for plenum installation.
- e Communication wiring shall be run in data cable tray whenever possible.

PART 4 - SOFTWARE

A MULTIPLE OPERATING PLATFORMS

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

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

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.

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

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.

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.

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

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

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

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.

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

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

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.

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

5 Environmental Index.

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.

6 ALARMS, TRENDS AND REPORTS

a System and Temperature Alarms

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.

b Trends

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.

c Reports

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

PART 5 - SEQUENCES OF OPERATION

A GENERAL

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

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

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

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.

E EQUIPMENT OPERATING SEQUENCES:

See next page

Jefferson County School District
Midway Elementary Addition/Remodel
Sequences of Operation

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PART 1 - GENERAL SEQUENCES – APPLIES TO ALL SYSTEMS

A Adjustable Parameters

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

B Power Loss to Control Modules

- 1 All control modules are equipped with battery backup and will retain programming, including time of day, upon loss of power. On return of power control functions will return to normal operation based on scheduling and time of day with no operator interface. Delay on start parameters can be setup at random intervals to prevent demand surges on restart.

C Power Loss to Server

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

D Trends

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

- 2 Trending will be setup for all significant I/O points. Analog values will be set to log every 5 minutes and store 288 data points for live retrieval. Binary points will be set to trend on Change of Value (COV) and to store 100 COV trend samples live. Sample frequency and quantity of stored data are adjustable within the memory limits of each module. e.g. Trends can be set to be logged every 5 minutes with 288 trend points allocated so that the live display will show 24 hours of trend data.
- 3 Trends are stored in module memory. Extended trending is available by archiving trends using Trend Historian for server storage.

E Schedules

- 1 Occupancy schedules will initiate from the zone level. Air handling units, chillers, boilers, pumps etc. whose operation is intended to provide air or water flow to zones will function based on Run Requests, Cooling Requests or Heating Requests from the zones they serve. These central systems will not have separate scheduling capability.
- 2 Schedules can be set for all systems in a customer database, or for a single building, a single floor, or for an individual zone. Additionally groups of equipment can be assembled in Schedule Groups for single entry scheduling of multiple zones for specific functions. For example a Gym Activities Group could be used for single entry scheduling for practices, ball games etc. Another example would be a group of rooms occupied by a single tenant who has frequent need for space conditioning during otherwise unoccupied times.
- 3 Schedules can be set for weekly reoccurring occupancy, dated weekly, date, date range, wildcard or continuous and can be set for multiple years in advance.
- 4 Timed Local Override (TLO), if available from the local sensor, will override unoccupied schedule, placing equipment in occupied operation for the programmed time period. TLO can be programmed for fixed duration, e.g. 180 minutes, or for time durations that accumulate with each push or pulse of the override button, e.g. 30 minutes per pulse with 180 minutes maximum override. The second option is the default standard.

F Unoccupied Operation

- 1 Whenever system operation is required to maintain low or high temperature limits during unoccupied hours of operation, PID control of heating and cooling functions will be bypassed and systems will go to 100% operation until setpoint is satisfied. HW or CHW valves or VAV dampers will drive to their full open position until setpoint is met.
- 2 Capability will be in the software to set an On/Off differential greater than occupied differential to reduce the frequency of unoccupied cycling, e.g. heating might be set to cycle on at 55 and remain on until 58°F is reached.

G Optimal Start

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

H Load to Source Control

- 1 Central air handling equipment serving multiple zones will operate based on Run Requests from connected zones.
- 2 Central systems such as boilers, chillers and pumps will operate based on Heating, Cooling or Run Requests from connected air handlers or zones as required.

I Outside Air Conditions

- 1 Outside air temperature will be monitored and averaged over a ten minute period. Alternate outside air temperature is available by default in programming and can be mapped to another site for backup or can be left unused.
- 2 Outside air conditions can be mapped to any controller for use for local control sequencing.

J Night Purge (Flush) Operation

- 1 System will be installed with programming for Night Purge operation designed to use low temperature night time air to pre-cool the facility during warm weather periods. Night Purge programming consists of a Global Broadcast to initiate three levels of purge at the zone level. Each zone will be programmed to receive Night Purge level broadcasts and initiate logic as described in the General Zone Sequences section below.
- 2 The DDC system will receive daily weather forecasts from the National Weather Service to provide Purge logic. Whenever the high temperature for the next day is forecast to be above 70° a global program will broadcast Purge Levels to all zone modules. When the forecast high is greater than 80°F Purge Level III will be broadcast to each zone. If
- 3 the forecast is between 75°F and 80°F a Level II broadcast will be sent. If the forecast is between 70°F and 75°F a Level I broadcast will be sent.
- 4 Night purge can be deactivated through DDC by time of year (month and day) or manually through DDC.

K Alarming

- 1 All alarms generated by WebCTRL may be setup for the following actions:
 - a Alarm Popup
 - b Print
 - c Propagate To Server
 - d Run External Program
 - e Send Alphanumeric Page
 - f Send E-Mail
 - g Write to File
- 2 If the system has the Advanced Alarming package, WebCTRL can also perform the following alarm actions:
 - a Send SNMP Trap
 - b Write Property
 - c Write to Database
- 3 All alarms may be enabled or disabled by the operator with out program change or memory download.
- 4 All alarms are set with default messages. Custom messages may be setup with out program change or memory download.
- 5 Not all available alarms are enabled except when requested or when it appears appropriate.

PART 2 - GENERAL ZONE SEQUENCES – APPLIES TO ALL UNITARY SYSTEMS

A Run Conditions

- 1 Zone shall have independent schedule capability. Scheduling shall be from a global schedule input, from local schedule or from a group schedule.
- 2 Outside air temperature shall be available from a global broadcast for local control options.
- 3 Demand level if provided in the project scope will be broadcast to this zone for set point offset or other demand control options.

B Zone Setpoint Control

- 1 Zone sensor in all areas except common areas and restrooms shall include set point adjustment and timed local override (optional). Setpoint adjustment shall be by means of an adjustable slide lever and setback override shall be from a button located on the sensor. Setback override can be cancelled by holding the momentary contact button down for 3 seconds. Default set point adjustment will be plus or minus 1°F and timed override will be 30 minutes per pulse with a maximum override of 180 minutes. Adjustment values and override times shall be programmable for each sensor.
- 2 Zone set point control uses a modified Zone PID algorithm to provide a smooth modulated or staged variable for cooling and heating. When zone equipment has single stage on/off control such as a single stage compressor, the equipment will cycle on at preset PID output and off when PID output drops to a lower preset level from the PID.
- 3 Zone control shall alarm on high or low zone temperature. Zone Temperature alarms will be disabled during Optimal Start, 1st 30 minutes of scheduled occupancy or during Setback override.
- 4 Supply air temperature monitor shall be included and shall alarm on high or low supply air temperature differential from space temperature.

C Night Purge Mode

- 1 Night Purge setpoints will be set by purge level from Global Night Purge Broadcast.
 - a Level 1 Night Purge cooling setpoint will be 69°F.
 - b Level 2 Night Purge cooling setpoint will be 67°F.
 - c Level 3 Night Purge cooling setpoint will be 65°F.
- 2 During Night Purge Mode OA or VAV dampers will not modulate, they will go to full open position until zone falls below cooling setpoint.

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

PART 3 - AIR HANDLING UNIT WITH ECONOMIZERS:

- 1 The AHU supply fan will start when the user adjustable time schedule in the DDC controller enters the occupied period. When the supply fan is started the controller will verify the supply fan status. If fan status is not proven an alarm will be issued at the user's P.C. Once run status is verified the controller will check the space temperature sensor assigned to each AHU to determine if cooling or heating is required. If cooling is required and outdoor air condition is suitable, the unit's internal controller will modulate the mixed air damper to maintain the supply air temperature setpoint. If outdoor condition is not suitable the mixed air dampers will be modulated to a minimum position as determined by the CO2 sensor (see sequence below). If mixed air dampers are at minimum position or the outdoor dampers are at 100% open and additional cooling is required, the controller will start the compressor cooling system to maintain the user adjustable cooling space setpoint. If heating is required the controller will energize the first stage of heat, if additional heat is required the second stage of heat is enabled to maintain space temperature heating setpoint. If the space temperature is between the heating and cooling setpoint, the supply fan will continue to operate, but neither heating nor cooling will be enabled. The occupied heating setpoint shall be 70°F and the cooling setpoint shall be 75°F. If equipped (see the specifications) the zone temperature sensor shall be adjustable to provide a +/- 3°F from the setpoint.
- 2 When the units are equipped with modulating power exhaust the control tubing will be brought into the space and setpoint to maintain a building pressure of +0.02" W.C. See the rooftop unit schedules for those units equipped with modulating power exhausters.
- 3 Indoor Air Quality (CO2 where indicated). Whenever the supply fan is on, the unit is in the occupied mode, and the space CO2 rises above its setpoint of 800 ppm and a deadband of 50 ppm (adjustable), the controller shall calculate a new minimum damper position necessary to maintain the CO2 setpoint. At no point shall the damper exceed the minimum damper position as established by the Balancing Contractor, unless the system is in economizer mode. As the CO2 level falls below its setpoint the routine shall lower its calculated value for the minimum damper position. IAQ shall be suspended whenever the average space temperature is outside the comfort limits. If the mixed air temperature begins to fall below 48°F the dampers shall be repositioned to maintain a minimum mixed air temperature of 48°F. A supply air temperature check shall be provided to not allow the discharge temperature to fall below the setpoint during the IAQ mode. The maximum damper position shall automatically change to 80% (operator adjustable) whenever the unit is indexed to the IAQ mode.
- 4 In the unoccupied mode the AHU supply fan will be stopped and the economizer damper shall be closed. If space temperature were to rise above or fall below the unoccupied space setpoints the AHU supply fan will start and heating or cooling will be enabled to maintain the space temperature at the unoccupied space temperature setpoint, the outside air dampers shall remain closed unless economizer cooling can be used. The unoccupied heating setpoint shall be 55°F and the cooling setpoint shall be 85°F.
- 5 In the standby mode those AHU units which serve classrooms, assembly areas, etc. and are equipped with occupancy sensors, shall be programmed with a standby mode of operation. The occupancy sensor shall be wired to the rooftop controller, indicating the room occupancy status. When the rooftop unit is scheduled to the occupied mode and the occupancy sensor has turned the lights off due to no space occupancy then the AHU unit shall reset the room setpoint 4°F off the current occupied setpoint and the outside air damper shall close. As the unit goes to standby the fan and compressor shall stop until the setpoint is no longer satisfied. The occupancy sensor will reactivate the lights and occupied setpoints when the room becomes in use.

PART 4 - UNIT VENTILATOR UNIT WITH ECONOMIZERS:

- 1 The AHU supply fan will start when the user adjustable time schedule in the DDC controller enters the occupied period. When the supply fan is started the controller will verify the supply fan status. If fan status is not proven an alarm will be issued at the user's P.C. Once run status is verified the controller will check the space temperature sensor assigned to each AHU to determine if cooling or heating is required. If cooling is required and outdoor air condition is suitable, the unit's internal controller will modulate the mixed air damper to maintain the supply air temperature setpoint. If outdoor condition is not suitable the mixed air dampers will be modulated to a minimum position as determined by the CO2 sensor (see sequence below). If mixed air dampers are at minimum position or

the outdoor dampers are at 100% open and additional cooling is required, the controller will start the compressor cooling system to maintain the user adjustable cooling space setpoint. If heating is required, the controller will modulate the steam valve to maintain space temperature heating setpoint. If the space temperature is between the heating and cooling setpoint, the supply fan will continue to operate, but neither heating nor cooling will be enabled. The occupied heating setpoint shall be 70°F and the cooling setpoint shall be 75°F. If equipped (see the specifications) the zone temperature sensor shall be adjustable to provide a +/- 3°F from the setpoint.

- 2 When the units are equipped with modulating power exhaust the control tubing will be brought into the space and setpoint to maintain a building pressure of +0.02" W.C. See the rooftop unit schedules for those units equipped with modulating power exhausters.
- 3 Indoor Air Quality (CO2 where indicated). Whenever the supply fan is on, the unit is in the occupied mode, and the space CO2 rises above its setpoint of 800 ppm and a deadband of 50 ppm (adjustable), the controller shall calculate a new minimum damper position necessary to maintain the CO2 setpoint. At no point shall the damper exceed the minimum damper position as established by the Balancing Contractor, unless the system is in economizer mode. As the CO2 level falls below its setpoint the routine shall lower its calculated value for the minimum damper position. IAQ shall be suspended whenever the average space temperature is outside the comfort limits. If the mixed air temperature begins to fall below 48°F the dampers shall be repositioned to maintain a minimum mixed air temperature of 48°F. A supply air temperature check shall be provided to not allow the discharge temperature to fall below the setpoint during the IAQ mode. The maximum damper position shall automatically change to 80% (operator adjustable) whenever the unit is indexed to the IAQ mode.
- 4 In the unoccupied mode the AHU supply fan will be stopped and the economizer damper shall be closed. If space temperature were to rise above or fall below the unoccupied space setpoints the AHU supply fan will start and heating or cooling will be enabled to maintain the space temperature at the unoccupied space temperature setpoint, the outside air dampers shall remain closed unless economizer cooling can be used. The unoccupied heating setpoint shall be 55°F and the cooling setpoint shall be 85°F.
- 5 In the standby mode those AHU units which serve classrooms, assembly areas, etc. and are equipped with occupancy sensors, shall be programmed with a standby mode of operation. The occupancy sensor shall be wired to the rooftop controller, indicating the room occupancy status. When the rooftop unit is scheduled to the occupied mode and the occupancy sensor has turned the lights off due to no space occupancy then the AHU unit shall reset the room setpoint 4°F off the current occupied setpoint and the outside air damper shall close. As the unit goes to standby the fan and compressor shall stop until the setpoint is no longer satisfied. The occupancy sensor will reactivate the lights and occupied setpoints when the room becomes in use.

END OF SECTION 23 0953

SECTION 23 1184 - STEAM AND CONDENSATE PIPING

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 22 0501 apply to this Section.

1.1 SUMMARY

- A. Furnish and install steam and condensate piping as described in Contract Documents.

1.1 QUALITY ASSURANCE

A. Cleaning System:

- 1.2 Thoroughly clean equipment, piping, and other material under this contract.
 - A. Remove rust, scale, and other dirt before painting or covering.
 - B. Remove rust, scale, and other dirt before operating the system.
- 1.3 Operate heating system at 10 psi for at least 6 hours, then -
 - A. Fill boiler to the top with water to wash any film, oil or grease over the top.
 - B. Drain boiler and refill to proper level with fresh water.
 - C. Use 1 pound tri-sodium phosphate for every 100 gallons of water during cleaning operation.
 - D. Tests:
- 1.4 No piping systems shall be covered or concealed until hydraulically tested at 50 psi in excess of maximum working pressure (100 psi minimum) and inspected and approved by Architect and any local inspector having jurisdiction.
- 1.5 When directed by Architect or Engineer, Contractor shall conduct an operating test on any piece of equipment to demonstrate its capacity and operating characteristics.

PART 2 - - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Steam Supply Piping
 - 1. Schedule 40-A-120 black steel piping.
 - 2. Pipe ends shall be reamed out before being made up into fittings.
 - 3. Use graphite and oil applied to male threads only in making pipe joint fittings.
 - 4. Fittings shall be standard weight 150 lb. malleable iron screwed pattern up to 2 1/2 inches.
 - 5. Piping over 2 1/2 inches shall be welded with full weld fittings.
- B. Condensate Piping:
 - 1. Schedule 80 black steel piping.
 - 2. Pipe ends shall be reamed out before being made up into fittings.
 - 3. Use graphite and oil applied to male threads only in making up pipe joint fittings.
 - 4. Fittings shall be standard weight 300 lb. malleable iron screwed pattern up to 2 1/2 inches.
 - 5. Piping over 2 1/2 inches shall be welded with full weld fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Heating piping shall run generally as indicated on the Drawings.
- B. Pipe ends shall be reamed and burrs removed.
- C. Unions shall be installed where necessary and on both sides of equipment and drip traps.
- D. Install float and thermostatic drip traps in sizes shown on drawings.
 - 1. Install at ends of steam mains.
 - 2. Install on raises in steam mains.
 - 3. Install dirt strainer and gate valve ahead of each drip trap.

- E. Runs of main piping shall start as high as possible.
 - 1. Keep as close to the ceiling as possible.
 - 2. Make sufficient allowance for grade and branches to be taken off top at 45 degree angles.
- F. Steam and return mains shall be graded downward in direction of flow 1 inch in 20 feet.
- G. Runouts and branches that grade back against flow of steam shall be graded 1/4 inch per foot.

END OF SECTION 23 1184

SECTION 23 1185 - CONDENSATE RETURN PUMP

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 15055 apply to this Section.

1.2 SUMMARY

- A. Furnish and install a condensate return pump as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Simplex packaged unit with duplex heavy cast iron receiver with supports and two pumps all piped on one base.
- B. Each pump shall have a capacity as shown and shall be operated from float switches, magnetic starter, and alternator provided with the pump and mounted on pump assembly.
- C. Approved Manufacturers:
 - 1. Federal
 - 2. Roth
 - 3. Pacific

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install check valve and gate valve on pump discharge.
- B. Run vent line from receivers and terminate as high as possible with return bends.

END OF SECTION 23 1185

SECTION 23 2118 – BACKFLOW PREVENTER VALVE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Designed to provide separation of radiant hot water heating system water from domestic cold water supply in accordance with Code.
 - 1. Rated flow at 30 psi pressure drop rated for 175 psi inlet pressure and 140 deg. F maximum operating temperature.
 - 2. Brass body construction with 3/4 inch NPT connections.
- B. Approved Manufacturers:
 - 1. Beeco 12
 - 2. Watts 900
 - 3. Equal by Febco
 - 4. Equal by Conbraco

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION 23 2118

SECTION 23 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. Carrier Corp, Syracuse, NY (800) 227-7437 or (315) 432-6000 www.carrier-commercial.com
 - b. Friedrich Air Conditioning Co, Austin, TX (800) 541-6645 or (210) 225-2000 www.friedrich.com
 - c. Mitsubishi Electronics America Inc, HVAC Div, Norcross, GA (800) 421-1140 or (770) 448-1268
 - d. 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 23 2166

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 23 3114

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, polyethylene 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 23 3346

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

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Anchor fan units securely to structure or curb.

END OF SECTION 23 3400

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
 - a. 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 23 3713

SECTION 23 5228 – UNIT 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 15055 apply to this Section.

1.2 SUMMARY

- A. Furnish and install unit ventilators as described in Contract Documents.

1.3 QUALITY ASSURANCE

- A. Air delivery shall be based on ASHRAE Standard Code for Testing and Rating Unit Ventilators. Units shall be tested and rated in accordance with this code.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Construction:
 - 1. Each unit shall be of draw through or blow through design with modular fan construction with each fan delivering 250 cfm standard air.
 - 2. Fan housings shall be constructed for reduced sound level. Fans shall be direct connected to 3-speed, permanent split capacitor motor mounted in unit compartment.
 - 3. Each unit shall be fitted with a motor switchbox with an on-off and a separate 3-speed switch, operable through an access door in unit top.
 - 4. Each unit shall be fitted with one outdoor air and one room air damper, interconnected or one combination damper.
 - 5. Unit shall have one filter with entire area in use at all times filtering both room and outdoor air.
 - 6. Unit chassis shall be constructed of 10 to 16 gauge steel of all-welded "unitized" construction. Chassis shall be dipped in primer after fabrication.
- B. Unit Cabinet:
 - 1. Unit cabinet shall be finished in smooth baked semi-gloss enamel, with "decorator" area finished in full gloss baked enamel in color selected by Architect.
 - 2. Unit shall be trimmed in an extruded aluminum frame with satin anodized finish and panels shall be formed of textured steel.
 - 3. Unit top surface shall be covered with 26 gauge vinyl-clad or plastic laminate clad steel, factory installed.
 - 4. Discharge grille shall be continuous and constructed of extruded aluminum.
 - 5. Access doors shall be extruded aluminum and shall match the discharge grille.
 - 6. Unit front cover shall be split into two panels for ease of handling. Construction shall be so that the panels may be removed to maintain the unit.
- C. Steam Heating Element:
 - 1. Steam heating element shall be constructed of non-freeze type with free floating tube ends and shall have inner steam distribution tubes.
 - 2. Heating element shall be fitted with a pressure equalizing device to prevent buildup of a vacuum in heating element when control valve is closing.
 - 3. Heating element shall also be fitted with a condensate cooling surface between outlet of heating element and steam trap to permit use of thermostatic traps.
- D. Operation - Unit must be capable of:
 - 1. Delivering room air or outdoor air up to full capacity.
 - 2. Being set to deliver a predetermined minimum of outdoor air.
 - 3. Automatically providing room air, predetermined quantity of outdoor or up to full capacity of outdoor air, as required by thermal needs of room.
- E. Controls:
 - 1. Unit shall be arranged for thermostatic control.
 - 2. Controls shall operate unit in manner described above.

3. Controls shall be installed in each unit with means provided for closing outdoor damper when unit fans are not operating.
4. Integral controls shall operate on a modified ASHRAE cycle II so that fresh air is not introduced during heating cycle.
5. Provide low limit discharge controller.

F. Filter:

1. Each unit shall be fitted with a renewable filter.

G. Outdoor Air Intake:

1. Outdoor air intakes shall be constructed with vertical chevron louvers in a 12 gauge frame designed to be load supporting.
2. Intakes shall be of the demountable type so louvers may be removed from the frame.
3. Frame and louvers shall be of anodized aluminum.
4. 1/2" square mesh aluminum screen shall be provided in back of the louver.
5. Louvers shall be furnished for masonry wall construction.

H. Approved Manufacturers:

1. TRANE
2. Or Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

- A. Controls shall be field adjusted by a factory serviceman.

3.3 FILTERS

- A. Provide two sets of filters for each unit.

END OF SECTION 23 5228

SECTION 23 5417 – HIGH EFFICIENCY NATURAL GAS FURNACE

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 gas fired condensing high efficiency furnace as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Fabrication:
 - 1. Furnaces shall be factory assembled units certified by AGA complete with blower section, furnace section, condensing coil, steel casing, piped, and wired.
 - 2. Blower section shall consist of cabinet, blower, and motor.
 - 3. Cabinet shall be of 22 gauge minimum cold rolled steel and have finish coat of baked-on enamel.
 - 4. Blower shall be Class 1, full DIDW, statically and dynamically balanced.
 - 5. Filters shall be one inch thick pleated throw-away type as furnished by furnace manufacturer.
 - 6. Provide furnace with accessory side mounted filter box frame and factory available bottom closure.
 - 7. Automatic controls:
 - a. 100% cut-off safety pilot
 - b. Manual gas shut-off valve
 - c. Operating automatic gas valve
 - d. Solid state type fan and thermal limit controls
 - e. 24 volt transformer
 - f. Electronic ignition system
 - g. Pressure switch safety for induced draft fan
- B. Units:
 - 1. Blower shall be driven by motor with adjustable pitch V-belt drive or by a multi-speed direct driven motor.
 - 2. Furnace section shall be enclosed in 22 gauge minimum enameled steel casing lined with foil covered insulation.
 - 3. Heat exchanger shall be ceramic or glass coated, stainless steel, or 18 gauge aluminized steel with 20 year minimum limited warranty.
 - 4. Units shall be rated at 93% minimum AFUE (Annual Fuel Utilization Efficiency) calculated in accordance with DOE test procedures.
 - 5. 2" or 3" intake and exhaust lines to outside with factory furnished combination flue/intake assembly for roof or sidewall.
- C. Approved Manufacturers:
 - 1. Lennox
 - 2. Carrier
 - 3. York
 - 4. Trane

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Quality Assurance: Furnace manufacturer's representative shall start up and check out furnace equipment as follows:
 - 1. Verify proper gas orifice sizing for altitude.
 - 2. Clock gas meter for rated input.
 - 3. Verify and set gas pressure at furnace.
 - 4. Check and measure temperature rise.
 - 5. Check safety controls for proper operation.

END OF SECTION 23 5417

SECTION 23 5533 – CABINET HEATER

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 cabinet heaters as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Floor mounted, upflow discharge or ceiling mounted, 14 gauge painted steel cabinet in color as selected by Architect, complete with inlet and outlet grilles, key lock access doors for valves and controls. Heating coil shall be steam type and factory equipped with:
 - 1. Fan speed control OFF-HIGH-MEDIUM-LOW
- B. Fan shall be forward curved with double inlet, mounted on motor shaft, and dynamically and statically balanced.
- C. Provide access panels for servicing motor and fans.
- D. Multi-speed fan motor shall be factory lubricated, have internal overload protection, and be resiliently mounted.
- E. Approved Manufacturers:
 - 1. Trane
 - 2. Airtherm
 - 3. Or Approved Equal

END OF SECTION 23 5533

SECTION 23 5540 - ELECTRIC RADIANT WALL 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 0501 apply to this Section.

1.2 SUMMARY

- A. Furnish and install wall heaters as described in Contract Documents.

1.3 QUALITY ASSURANCE

- A. Units shall be UL listed and comply with NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Fan type for recess mounting in wall.
- B. 20 gauge minimum sheet metal casing.
- C. Heating element shall be encased in steel finned casting and protected by thermal switch.
- D. Fan motor shall be heavy duty enclosed and permanently lubricated.
- E. Fan shall be precision balanced and fan-motor assembly mounted to be vibration free.
- F. Units shall be controlled automatically by integral thermostat when heater is in "ON" position.
- G. Heater shall have built-in fan delay.
- H. Finish - Baked-on enamel.
- I. Approved Manufacturers:
 - 1. Q' Mark
 - 2. Berko
 - 3. Thermador
 - 4. Markel

END OF SECTION 23 5540

SECTION 23 6213 - AIR-COOLED CONDENSING UNITS (2-5 TONS)

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 condensing units as described in Contract Documents.

1.3 WARRANTY

- A. Five-year warranty on compressors.
 - 1. Warranty time frame shall be five years from date of "start-up". "Start-up" date shall be recorded on warranty certificate for each unit.

PART 2 - PRODUCTS

2.1 TWO TON THROUGH FIVE TON UNITS

- A. Condenser coil shall have aluminum plate fins mechanically bonded to seamless copper tubes.
 - 1. Provide coil guard for unit.
- B. Fans shall be direct driven propeller upflow type.
 - 1. Fan motor shall be single or two speed, thermostatically controlled, permanently lubricated, and designed with permanent protection and ball bearings.
 - 2. Motors shall be resiliently mounted.
 - 3. Each fan shall have a safety guard.
- C. Units shall be operable down to 0 deg F outdoor temperature.
- D. Compressor shall be of hermetic design with the following features. Each condenser unit shall have only one compressor.
 - 1. Externally mounted brass service valves with charging connections.
 - 2. Crankcase heater.
 - 3. Resilient rubber mounts.
 - 4. Compressor motor overload protection.
 - 5. Single speed
- E. Controls:
 - 1. Factory wired and located in separate enclosure.
 - 2. Safety devices shall consist of high and low pressure cutout and condenser fan motor overload devices.
 - 3. Unit shall have anti-cycle timers to prevent units from starting up again for five minutes after any power interruption.
- F. Casing:
 - 1. Fully weatherproof for outdoor installation. Finish shall be weather resistant.
 - 2. Openings shall be provided for power and refrigerant connections.
 - 3. Panels shall be removable for servicing.
- G. Expansion Valves:
 - 1. Stainless steel diaphragm and same refrigerant in thermostatic elements as in system. Externally or internally equalized as required by evaporator/condensing system.
 - 2. Size valves to provide full rated capacity of cooling coil served.
 - 3. Furnished by evaporator coil/condensing unit supplier and coordinated to provide bleed holes for system pressure equalization, if required.
- H. Condensing units shall use R-410A refrigerant. Only one liquid line, one suction line, and one power connection shall be made to each compressor. Provide charging valves.

- I. SEER rating as defined by ARI shall be not less than 13.0.
- J. Set each unit on neoprene isolation pads located at each corner and sized 4" x 4" x 3/4" high minimum.
- K. Approved Manufacturers:
 - 1. York
 - 2. Carrier
 - 3. Lennox
 - 4. Trane

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set condensing units as detailed on the drawings.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service:
- B. Condensing units shall be started up, checked out, and adjusted by Condensing Unit Manufacturer's authorized factory trained service mechanic.
- C. Mechanic shall use check-out sheet provided by Manufacturer, complete and sign all items on sheet, and submit to Architect.

END OF SECTION 23 6213

SECTION 23 6215 - AIR COOLED CONDENSING UNIT (6 TONS AND LARGER)

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. Provide and install condensing units as described in Contract Documents.
- B. Furnish and install complete a hot gas by-pass system.

1.3 QUALITY ASSURANCE

- A. Requirements of Regulator Agencies:
 - 1. Each unit shall be UL labeled.

1.4 WARRANTY

- A. Five-year warranty on compressors.
- B. Two-year warranty on condensing unit.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Unit shall be completely factory assembled and shall be given a thorough running factory performance test at normal operating conditions.
- B. Unit shall be shipped as a single package on a common base and lifting lugs shall be provided for handling.
- C. Casing:
 - 1. Casing shall be fabricated of 12 gauge .080 inch textured aluminum sheathing and thoroughly reinforced.
 - 2. Structural members shall be fabricated of continuous galvanized steel or galvanized structural steel channel.
- D. Compressor:
 - 1. Accessible hermetic type
 - 2. Suction and discharge service valves
 - 3. Crankcase heaters
 - 4. Oil sight glass and oil charging connection.
 - 5. Force feed lubrication system with reversible oil pump and operating oil charge.
 - 6. Compressor motors:
 - a. High torque
 - b. Hermetic induction type
 - c. 1750 rpm with inherent thermal protection
 - 7. Compressors shall be mounted on vibration absorbing mounts.
- E. Condenser Coil:
 - 1. Constructed of 1/2 inch O.D. seamless copper tubes and rippled, plate type aluminum fins.
 - 2. Fins shall be mechanically bonded to the tubes.
 - 3. Fins shall have full drawn collars to completely cover the copper tube against atmospheric corrosion.
 - 4. Provide factory coil guards.
- F. Sub-cooling Coil:
 - 1. Integral with the main condenser coil
 - 2. Minimum of 15 degrees liquid sub-cooling for improved system performance and longer piping runs without flash gas.

- G. Condenser Fans:
 - 1. Fan section:
 - a. Furnished with propeller fans arranged for vertical air discharge.
 - b. Divided by full width baffles between fans.

- H. Fans:
 - 1. Statically and dynamically balanced
 - 2. Individually driven by separate fan motors.
 - 3. Permanently lubricated, ball bearing motors with inherent thermal overload protection.
 - 4. Motors for direct drive fans shall not exceed 1140 rpm.
 - 5. Motors for belt drive fans shall not exceed 1750 rpm.

- I. Low Ambient Control:
 - 1. Units shall be provided with automatic head pressure control by cycling condenser fans in response to ambient temperature.
 - 2. Control Center:
 - a. Controls shall be contained within a weatherproof cabinet with key lock.
 - b. Dual compartments shall isolate safety and operating controls from starting equipment.
 - c. Control panel shall have dead-front construction for operator's safety.
 - d. Control center shall include:
 - 1) System on-off switch
 - 2) Compressor on-off switch
 - 3) Oil safety switch
 - 4) High and low pressure controls
 - 5) Pumpdown relay
 - 6) Fan cycling thermostat

- J. Dual or tandem compressor models shall include time delay sequenced start.

- K. Power and starting equipment for compressor and condenser fan motors shall include:
 - 1. Three-leg companion trip circuit breakers and starting contactors
 - 2. Overload protection
 - 3. Power terminal block

- L. Factory Performance Test:
 - 1. Each unit shall be individually tested at full and partial load conditions.
 - 2. With unit in operation, controls shall be properly calibrated and adjusted.
 - 3. After performance testing, unit shall be thoroughly leak tested with a high sensitivity electronic leak detector.

- M. Refrigerant:
 - 1. Unit shall be shipped with holding charge of Refrigerant-410a.

- N. Approved Manufacturers:
 - 1. Trane
 - 2. McQuay
 - 3. Carrier
 - 4. York
 - 5. Or Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set condensing unit on roof curb supplied by manufacturer.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service:

- 3.3 Condensing units shall be started up, checked out, and adjusted by Condensing Unit Manufacturer's authorized factory trained service mechanic.
- 3.4 Mechanic shall use check-out sheet provided by Manufacturer, complete and sign all items on sheet, and submit to Architect.

END OF SECTION 23 6215

SECTION 23 6218 – AIR HANDLING UNITS WITH COILS

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 air handling units as described in Contract Documents.

1.3 QUALITY ASSURANCE

- A. Units with coils shall be ARI certified and bear certification symbol.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Cabinets:
 - 1. Constructed of heavy gauge steel with protective enamel on zinc coated finish, adequately braced and reinforced, and of sectionalized construction.
 - 2. Panels shall be removable for easy access to interior of unit.
 - 3. With interior mounted motors, hinged access doors with cam locks.
 - 4. Cabinet panels shall be internally insulated with one inch thick, 3/4 lb density, vinyl coated glass fiber insulation.
 - 5. Seal joints with permanent type flexible mastic.
- B. Provide insulated drain pan with condensate drain connections at each end. Extend drain pan under coil headers and refrigerant distributors. Plug unused ends.
- C. Fans:
 - 1. Double inlet, double width, forwardly curved centrifugal type designed for Class I operation.
 - 2. Base fan ratings on tests conducted in accordance with AMCA Code #210.
 - 3. Construct fan housings with streamline inlet and side sheets.
 - 4. Fans shall be statically and dynamically balanced and tested. Maximum rated fan RPM shall be well below first critical fan shaft speed.
- D. Fan Shaft:
 - 1. Solid high carbon steel.
- E. Bearings:
 - 1. Self-aligning, grease lubricated, ball type, and sized minimum service factor of 4.
 - 2. Provide lubrication fittings. Permanently lubricated bearings are not acceptable.
 - 3. Provide extended lubrication lines to accessible side of unit.
- F. Rate V-belt drives at 150% of motor rating:
 - 1. Motor sheaves shall be of adjustable pitch type giving 30% speed variation.
 - 2. Fabricate belt guards from 16 gauge galvanized steel rigidly supported.
 - 3. Provide 1-1/2 inch diameter tachometer holes for both fan and motor shafts.
- G. Motors:
 - 1. As described in Contract Documents and mounted external to fan-coil unit on rubber isolated base incorporating a device for belt tightening or internal to unit with fan, motor, and drive assembly internally isolated.
 - 2. Locate motor on side of unit most accessible in Mechanical Room.
- H. Cooling Coils:
 - 1. Direct expansion type with plate type aluminum fins and copper tubes, ARI certified.
 - 2. Arrange cooling coil vertically in coil section.

3. Completely enclose coil headers and refrigerant distributors in insulated casing with only connections extended through cabinet.
4. Liquid and suction connections shall be on same end of coil.
5. Circuit coils as shown or as required for capacity reduction.

I. Heating Coils

1. Steam coils shall be of the plate fin extended surface type. Tubes shall be 5/8" outside diameter seamless copper with a 0.020" minimum wall thickness. Each coil shall have individually replaceable return bends of 0.025 wall thickness on both sides of the coil. Coils incorporating a "hairpin" type design are not acceptable. Tubes shall be expanded into the fin collars to provide a permanent mechanical bond
2. The secondary surface shall be formed of 0.006" (.008, .010) aluminum (copper) fins and shall be spaced not closer than 12 fins per inch with integral spacing collars that cover the tube surface. Headers shall be non-ferrous seamless copper, outside the airstream and provided with brazed copper male pipe connections. Drain and vent tubes shall be extended to the exterior of the air handling unit.
3. All coils shall have counterflow construction with connections left or right hand as shown on the drawings. The use of internal restrictive devices to obtain turbulent flow will not be accepted.
4. Intermediate condensate pans are to be furnished on multiple coil units and single coils greater than 48" high. The pans shall be 16Ga. 304 stainless steel and drain to the main drainpan through copper downspouts.
5. All water coils shall be rated in accordance with ARI Standard 410.
6. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all coils supplied for the air handlers.

J. Filter Boxes:

1. Provide with hinged access doors and quick release locking handles.
2. Provide end fillers as necessary to prevent by-passing of air.
3. Provide one inch wide 16 gauge galvanized steel filter removal strap with one end bent up one inch to form hook. Lay strap in bottom of each filter support channel.

K. Approved Manufacturers:

1. Carrier 39E
2. McQuay
3. Trane Climate Changer
4. York

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set units on spring type vibration isolators sized as recommended by Unit Manufacturer and so springs will not bottom out when unit is set on isolators.

END OF SECTION 23 6218

END OF DIVISION 23