



ALPINE CAMPUS CENTER

ENERGY UPGRADES

PROJECT SPECIFICATIONS

(CONSTRUCTION DOCUMENTS)

June 29, 2017

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SECTION 23 05 00 - COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. All drawings associated with the entire project, including general provisions of the Contract, including The General Conditions of the Contract for Construction, General and Supplementary Conditions and Division-1 Conditions specification sections shall apply to the Division 21, 22, and 23 specifications and drawings. The Contractor shall be responsible for reviewing and becoming familiar with the aforementioned and all other Contract Documents associated with the project.
- B. Related Sections: Refer to all sections in Division 21, 22, and 23. Refer to Division 26 specification sections and Division 26 drawings.
- C. Where contradictions occur between this section and Division 1, the more stringent requirement shall apply.
- D. Contractor shall be defined as any and all entities involved with the construction of the project.

1.2 SUMMARY:

- A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Divisions 21, 22, and 23. It expands and supplements the requirements specified in Division 1.

1.3 MECHANICAL INSTALLATIONS:

- A. The Contract Documents are diagrammatic, showing certain physical relationships which must be established within the mechanical work and its interface with all other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.
- B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements.
- C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, Contractor shall take the necessary measurements and prepare the drawings.
- D. The exact location for some items in this specification may not be shown on the drawings. The location of such items may be established by the Engineer during the progress of the work.
- E. The contract documents indicate required size and points of terminations of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. It is not intended that drawings indicate necessary offsets. The contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner. All equipment shall be installed so access is maintained for serviceability.

- F. Before any work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as intended without interferences between systems, structural elements or work of other trades.
- G. Verify all dimensions by field measurements.
- H. Coordinate installation in chases, slots and openings with all other building components to allow for proper mechanical installations.
- I. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- J. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- K. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- L. Make allowance for expansion and contraction for all building components and piping systems that are subject to such.
- M. The ceiling space shall not be "layered". It is the contractor's responsibility to offset and system as required to allow installation within the identified ceiling cavity. The contractor shall include labor and material in the base bid to accommodate such offsets.
- N. In general, all "static" piping systems shall be routed as high as possible, i.e. fire protection systems. Keep all equipment in accessible areas such as corridors and coordinate with systems and equipment from other sections.
- O. The Contractor shall provide all labor and material necessary but not limited to the starting/stopping of all mechanical equipment, opening/closing of all valves, draining/refilling all mechanical systems and operating/verifying the operation of all mechanical systems controls as required to accomplish all work necessary to meet construction document requirements. Contractor shall submit records of such activities to engineer and include in the O & M manuals.

1.4 COORDINATION:

- A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, isolation valves, offsets, hangers, control devices, etc., necessary to overcome congested conditions at no increase in contract sum. The Contractors base bid shall include any and all time and manpower necessary to develop such coordination efforts and drawings. Increases to contract sum or schedule shall not be considered for such effort.
- B. Existing Conditions:
 - 1. Carefully survey existing conditions prior to bidding work.
 - 2. Provide proper coordination of mechanical work with existing conditions.
 - 3. Report any issues or conflicts immediately to Engineer before commencing with work and prior to purchasing equipment and materials.

1.5 PROJECT CONDITIONS:

- A. The Contractor shall be required to attend a mandatory pre-bid walk-thru and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for existing conditions.
- B. Field verify all conditions prior to submitting bids.
- C. Report any damaged equipment or systems to the Owner prior to any work.
- D. Protect all mechanical and electrical work against theft, injury or damage from all causes until it has been tested and accepted.
- E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.
- F. The Contractor shall coordinate and co-operate with Owner at all times for all new to existing connections, system shutdowns and start-ups, flushing and filling both new and existing systems.
- G. Provide temporary ductwork and piping services, where required, to maintain existing areas operable.
- H. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, one week in advance.
- I. Minimize disruptions to operation of mechanical systems in occupied areas.

1.6 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Refer to Division 1.
- B. Execute and inspect all work in accordance with all Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed. Follow recommendations of NFPA, SMACNA, EPA, OSHA and ASHRAE.
- C. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.
- D. The handling, removal and disposal of regulated refrigerants and other materials shall be in accordance with U.S. EPA, state and local regulations.
- E. The handling, removal and disposal of lead based paint and other lead containing materials shall comply with EPA, OSHA, and any other Federal, State, or local regulations.
- F. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

1.7 PERMITS AND FEES:

- A. The Contractor shall pay all tap, development, meter, etc., fees required for connection to municipal and public utility facilities, unless directed otherwise by the General Contractor/Owner – IN WRITING.
- B. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.

1.8 PRODUCT OPTIONS AND SUBSTITUTIONS:

- A. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.
- B. Materials and equipment of equivalent quality may be submitted for substituted prior to bidding. This may be done by submitting to the Architect/Engineer at least ten (10) working days prior to the bid date requesting prior review. This submittal shall include all data necessary for complete evaluation of the product.
 - 1. Substitutions shall be allowed only upon the written approval of the Architect/Engineer NO EXCEPTIONS.
 - 2. The Contractor shall be responsible for removal, replacement and remedy of any system or equipment which has been installed which does not meet the specifications or which does not have prior approval.

1.9 MECHANICAL SUBMITTALS:

- A. General
 - 1. Refer to the Conditions of the Contract (General and Supplementary), Division 1.
 - 2. Contractor shall provide a submittal schedule appropriate for the size and schedule of the project. Limit the number of large submittals being reviewed at one time and coordinate timing of sections that are dependent on each other.
 - 3. The Contractor shall identify any "long lead time" items which may impact the overall project schedule. If these submittal requirements affect the schedule, the Contractor shall identify the impacts and confer with the Engineer within two weeks of entering into the contract.
 - 4. The front of each submittal package shall be identified with the specification section number, job name, Owner's project number, date, Prime Contractor and Sub-Contractor's names, addresses, and contact information, etc. Each Specification Section shall be submitted individually and submittal shall be tabbed for the equipment/materials/etc. within the section. Submittals that are not complete with the required information will not be reviewed and will be sent back to be corrected.
 - 5. Submittals shall be provided electronically. All electronic submittals need to be complete with all design information and stamped for conformity by the contractor. Submittals will be reviewed, marked appropriately and returned by the same means received.
 - 6. An index shall be provided which includes:
 - a. Product
 - b. Plan Code (if applicable)

- c. Specification Section
 - d. Manufacturer and Model Number
7. Submittal schedule shall be provided for review within four (4) working weeks from award of contract to successful bidder.
- B. Basis of Design: The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the basis of design and provide for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.
- C. All equipment shall conform to the State and/or local Energy Conservation Standards.
- D. Contractor Review: Submittal of shop drawings, product data and samples will be accepted only when submitted by and stamped by the General Contractor. Each submittal shall be reviewed by the contractor for general conformance with contract requirements and stamped by the respective contractor prior to submittal to the Architect/Engineer. Any submittal not stamped or complete will be sent back. Data submitted from Subcontractors and material suppliers directly to the Engineer will not be processed unless prior written approval is obtained by the Contractor.
- E. Submittal Review Process: Before starting work, prepare and submit to the Architect/Engineer shop drawings and descriptive equipment data required for the project. Continue to submit in the stated format after each Architect/Engineer's action until a "No Exception Taken" or "Make Correction Noted" action is received. When a "Make Corrections Noted" is received, make the required corrections for inclusion in the Operating and Maintenance Manual (O&M). Submittals marked "Make Corrections Noted" shall not be resubmitted during the submittal process. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned "Revise and Resubmit". Where an entire submittal package is returned for action by the Contractor, the Engineer may summarize comments in letter format and return the entire set. Submittals shall be prepared per the MECHANICAL SUBMITTAL CHECKLIST, of this section; supplemental requirements are listed in each Division 21, 22, and 23 Sections.
- F. The Design Professional's review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:
- 1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
 - 2. Construction means or methods
 - 3. Coordination of the work with other trades
 - 4. Construction safety precautions
- G. The Design Professional's review shall be conducted with reasonable promptness while allowing sufficient time in the Design Professional's judgment to permit adequate review. Review of a specific item shall not indicate that the Design Professional has reviewed the entire assembly of which the item is a component.
- H. The Design Professional shall not be responsible for any deviations from the contract documents not brought specifically to the attention of the Design Professional in writing by the Contractor. This shall clearly identify the design and the specific element which vary from the Design. The Contractor shall be responsible for all remedy for lack of strict conformance associated with this criteria.

- I. The Design Professional shall not be required to review partial submissions or those for which submissions of correlated items have not been received.

1.10 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS:

A. Product Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
2. Delete or mark-out portions of pre-printed data which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For each product, include the following:
 - a. Sizes.
 - b. Weights.
 - c. Speeds.
 - d. Capacities.
 - e. Piping and electrical connection sizes and locations.
 - f. Statements of compliance with the required standards and regulations.
 - g. Performance data.
 - h. Manufacturer's specifications.

B. Shop Drawings:

1. Shop Drawings are defined as mechanical system layout drawings prepared specifically for this project, or fabrication and assembly type drawings of system components to show more detail than typical pre-printed materials.
2. Prepare Mechanical Shop Drawings, except diagrams, to accurate scale, min 1/8"-1'-0", unless otherwise noted.
 - a. Show clearance dimensions at critical locations.
 - b. Show dimensions of spaces required for operation and maintenance.
 - c. Show interfaces with other work, including structural support.

C. Test Reports:

1. Submit test reports which have been signed and dated by the accredited firm or testing agency performing the test.
2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.
3. Submit test reports as required for O & M manuals.

D. Product Listing:

1. Prepare listing of major mechanical equipment and materials for the project, within (2) two weeks of signing the Contract Documents and transmit to the Architect. A sample schedule is included at the end of this section to complete this requirement.
 - a. Provide all information requested.
 - b. Submit this listing as a part of the submittal requirement specified in Division 1, "PRODUCTS AND SUBSTITUTION."

2. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.
 3. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units and similar items used in work, except as otherwise indicated.
 - a. Provide products which are compatible within systems and other connected items.
- E. Schedule of Values
1. Provide preliminary schedule of values with product data submittal, within three (3) weeks from award of contract to successful bidder.
 2. Provide a final Schedule of Values at close-out of project including updated values based on actual installation.
- F. Required Submittals: Provide submittals for each item of equipment specified or scheduled in the contract documents. See table at the end of this section.
- G. If more than two submittals (either for product data, shop drawings, record drawings, or test and balance reports) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.
- H. The contractor shall cloud all changes made on submittals that are marked "Revise and Resubmit."
- 1.11 DELIVERY, STORAGE, AND HANDLING:
- A. Refer to Division 1 Sections on Transportation and Handling and Storage and Protection.
 - B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged and protected to prevent damage or contamination during shipment, storage, and handling.
 - C. Check delivered equipment against contract documents and submittals.
 - D. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage, dirt, dust, freezing, heat and moisture.
 - E. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.
 - F. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.
 - G. Protect stored ductwork, pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

- H. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or be packaging with durable, waterproof wrapping.
- I. Protect sheet metal ductwork and fittings. Elevate and store above grade and cover ends with waterproof wrapping.

1.12 CUTTING AND PATCHING:

- A. This Article specifies the cutting and patching of mechanical equipment, components and materials to include removal and legal disposal of selected materials, components and equipment. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- B. Refer to Division 1.
- C. Do not endanger or damage installed work through procedures and processes of cutting and patching.
- D. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.
- E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective or non-conforming installations.
- F. Perform cutting, fitting and patching of mechanical equipment and materials required to:
 - 1. Uncover work to provide for installation of ill-timed work;
 - 2. Remove and replace defective work;
 - 3. Remove and replace work not conforming to requirements of the Contract Documents;
 - 4. Remove samples of installed work as specified for testing;
 - 5. Install equipment and materials in existing structures;
 - 6. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect /Engineer observation of concealed work.
- G. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim and other mechanical items made obsolete by the new work.
- H. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.
- I. Provide and maintain an approved type of temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas. Temporary partitions must not impede access to building egress.
- J. Locate identify, and protect mechanical and electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover. Cover openings in ductwork to remain. Protect equipment and systems to remain.

1.13 ROUGH-IN:

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

- B. Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough-in requirements.
- C. Work through all coordination before rough-in begins.

1.14 ACCESSIBILITY:

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.
- B. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification and Division 23 for duct access door requirements.
- C. The minimum size of any access door shall not be less than the size of the equipment to be removed or 12 inches x 12 inches if used for service only.
- D. Furnish doors to trades performing work in which they are to be built, in ample time for building-in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.
- E. Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed. In lieu of these doors, approved shop fabricated access doors with DuroDyne hinges may be used.
- F. Access doors in fire-rated walls and ceilings shall have equivalent U.L. label and fire rating.
- G. Final installed conditions shall accommodate accessibility and replacement of system components that regularly require service and replacement. This includes control devices, sensors, motors, etc.. Such devices shall not be permanently obstructed by building systems such as piping, ductwork, insulation, drywall, etc.

1.15 NAMEPLATE DATA:

- A. Provide permanent operational data nameplate, refer to the section on Mechanical Identification, on each item of mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Coordinate with Owner for specific requirements.

1.16 RECORD DOCUMENTS:

- A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.
- B. Keep a complete set of record document prints in custody during entire period of construction at the construction site. Documents shall be updated on a weekly basis.
- C. Mark Drawing Prints to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control

devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping or ductwork relocated more than 1foot-0inches from where shown on the drawings.

- D. Mark shop drawings to indicate approved substitutions; Change Orders; actual equipment and materials used.
- E. Mark equipment and fixture schedules on drawings to indicate manufacturer and model numbers of installed equipment and fixtures.
- F. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme:
 - 1. Red shall indicate new items, deviations and routing.
 - 2. Green shall indicate items removed or deleted.
 - 3. Blue shall be used for relevant notes and descriptions.
- G. At the completion of the project, obtain from the Architect a complete set of the Mechanical Contract Documents in a read-only electronic format (.pdf unless otherwise noted). This set will include all revisions officially documented through the Architect/Engineer. Using the above color scheme, transfer any undocumented revisions from the construction site record drawings to this complete set. Submit completed documents to the Architect/Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the Architect/Engineer.
- H. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up .pdf format readable by Bluebeam is preferred.

1.17 OPERATION AND MAINTENANCE DATA:

- A. No later than four (4) weeks prior to the completion of the project provide one complete set of Operating and Maintenance Manuals, or as specified in Sections of Division 1 (whichever is more stringent).
- B. The testing and balancing report shall be submitted and received by the Engineer at least fifteen calendar days prior to the contractor's request for final observation time frame requirements. Include in the O & M Manual after review with "No Exceptions Taken" has been accomplished.
- C. Include the following information:
 - 1. The job name and address and contractor's name and address shall be identified at the front of the electronic submittal.
 - 2. Description of mechanical equipment, function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 - 3. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions. Provide any test reports and start-up documents.
 - 4. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

5. Servicing instructions, lubrication charts and schedules, including Contractor lubrication reports.
 6. Manufacturer's service manuals for all mechanical equipment provided under this contract.
 7. Include the valve tag list.
 8. Name, Address and Telephone numbers of the Sub-contractors and local company and party to be contacted for 24-hour service and maintenance for each item of equipment.
 9. Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.
 10. Complete recommended spare parts list.
 11. Mechanical System and Equipment Warranties.
 12. Copies of all test reports shall be included in the manuals.
 13. Provide manuals with dividers for major sections and special equipment. Mark the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.
 14. Final schedule of values with all mechanical change order costs included and identified.
 15. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up PDF format readable by Bluebeam is preferred.
- D. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, and final Schedule of Values with all Electrical and Information Technology change order costs included and identified is provided and the manual is reviewed by the Architect/Engineer.
- 1.18 PROJECT CLOSEOUT LIST:
- A. In addition to the requirements specified in Division 1, complete the requirements listed below.
 - B. The Contractor shall be responsible for the following Mechanical Submittal Checklist either by performing and/or coordinating such items prior to applying for certification of substantial completion. Refer to individual specification sections for additional requirements. (Checklist is located at the end of this section.)
- 1.19 WARRANTIES:
- A. Refer to the Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In any case the entire mechanical system shall be warranted no less than one year from the time of acceptance by the Owner.
 - B. Compile and assemble the warranties specified in Division 21, 22, and 23, into the Operating and Maintenance Manuals.
 - C. Provide complete warranty information for each item to include product or equipment to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.
- 1.20 CONSTRUCTION REQUIREMENTS:
- A. The contractor shall maintain and have available at the jobsite current information on the following at all times:
 1. Up to date record drawings.
 2. Submittals

3. Site observation reports with current status of all action items.
4. Test results; including recorded values, procedures, and other findings.
5. Outage information.

1.21 MECHANICAL SUBMITTAL CHECKLIST:

Spec Section	Item	Requirements							
		Submittals			Supplemental		Factory Rep Super-Vision At Site	Training Req'd At Site	Extra Material
		Shop Drawings	Product Data	Include In O & M	Test ³	Report ³			
230500	Preliminary Schedule Of Values					X			
	Final Schedule Of Values			X		X			
	Equipment Warranties			X					
	O&M Manuals								
	Coordination Drawings	X							
	Record Drawings	X	X	X					
230923	Direct Digital Control Systems	X	X	X		X	X	X	
230993	Sequence Of Operation			X					

END OF SECTION 23 05 00

SECTION 23 09 00 – INSTRUMENTATION AND CONTROL FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. General: The Control System Contractor shall utilize the existing ATS control system using new control devices to operate as specified. The contractor shall inspect the existing conditions prior to submitting a proposal.
- B. The Control Contractor will be responsible for all installation, programming, commissioning, testing and performance verification.
- C. The Controls Contractor will be responsible for providing all devices required for a complete operating control system.
- D. It shall be a digital, distributed microprocessor-based system with a pneumatic and electronic interface, where required. The Control System for this project will be referred to as a Building Automation System (BAS).
- E. Total quantity and type of control points shall consist of specifications, drawings and as required to complete the sequence of operation as specified. Additional points shall be provided as required to meet all sequence of operation functions, safeties and data base. The drawings and Specifications are not intended to show all details necessary to make the system complete and operable.
- F. The Control Contractor shall be responsible for all phases of software design, all equipment, installation and warranty for the BAS. The Control Contractor shall be responsible for supplying and installing all necessary control devices for completing the BAS.
- G. The system shall include all control device, valves, interlocks, field devices, hardware, software, automatic dampers, piping, fittings, wire, conduit, etc., as specified and required and connected so as to perform all functions and operate according to the specified sequences.
- H. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner or Architect/Engineer in writing. Unless approved otherwise, all products (including firmware revisions) used in this installation shall have been used in at least twelve (12) projects prior to this installation. The previous sites may be located anywhere in the U.S.A. This requirement is not intended to restrict the Contractor to the use of any outdated equipment. Therefore, all products used in this installation shall also be currently under manufacture and have available, for at least ten years after completion of the contract, a complete line of spare parts. If the above requirements are mutually exclusive, the Contractor shall include a specific statement to this effect in the Bid.
- I. Refer to other Division 23 sections for installation of instrument wells, valve bodies and dampers in mechanical systems.
- J. Provide electrical work as required, including but not limited to, the following:
 - 1. Interlock and control wiring between field-installed controls, indicating devices and unit control panels.

- K. Control Contractor shall furnish & identify location requirements for all necessary control devices which may be installed by others including the following, but not limited to:

- 1. Motorized dampers.

1.2 QUALITY ASSURANCE:

- A. Contractors Qualifications: Firms regularly engaged in installation and commissioning and servicing of digital control equipment, of types and sizes required, whose firm has been in business in similar service for not less than 5 years.
- B. All work of this Section shall be fully "Year 2000 Compliant". See Section 23 05 00 "Common Work Results for Mechanical". All date related data shall use four digit dates. "Windowing" of dates is specifically prohibited.
- C. Only those manufacturers specified are allowed to bid temperature controls. All bidders shall make available, upon the Owner's request, open book unit pricing of all materials and labor.
- D. The system shall be installed by competent mechanics, regularly employed by the Temperature Control Contractor.
- E. All bidders must have installed and completed at least two (2) direct digital temperature control jobs of similar design, size and scope using the same equipment as specified.
- F. All bidders must have a local office in the area of the project site.
- G. All bidders must have capabilities of doing component level repairs on all systems, including electronic systems.
- H. No Field Devices shall be multiplexed to a single I/O point unless specified. Each control or sensing point shall be terminated at a unique location on the BAS panel, Slave or Dedicated Controller and be associated with a unique software point on the BAS.
- I. Codes and Standards:
 - 1. All equipment and the installation shall comply with the requirements of all applicable local and national codes including but not limited to the currently enforced edition of the International Building, International Fire, International Mechanical and all applicable codes of the National Fire Protection Association including the National Electrical Code.
 - 2. Electrical Standards: Provide electrical products, which have been tested, listed and labeled by UL and comply with NEMA standards.
 - 3. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.
 - 4. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
- J. All bidders must have a minimum of one person dedicated to software generation. This person shall be located in an office local to the project site.
- K. The equipment and software proposed by the supplier shall be currently in manufacture. No custom products shall be allowed unless required by the Specification. All products shall be supported by the manufacturer for a minimum of 5 years including spare parts, board repairs and software revisions.

- L. The Temperature Control Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others work.
- M. It will be the responsibility of the Contractor to work in cooperation with the Owner and with all other contractors and employees rendering such assistance and so arrange his work such that the entire project will be delivered complete in the best possible condition and in the shortest time.

1.3 PROPRIETARY INFORMATION:

- A. Project Documentation: All custom software, programs, code, databases, graphic files and drawings (whether hard copy or CADD based files) prepared for this system shall be the exclusive property of the Owner and shall not be reproduced or distributed without prior written permission from the Owner.
- B. The use or reference to the Owner or any of its subsidiaries or any of the facility automation projects shall not be used by the Manufacturer or Contractor in any promotional media, including advertisements, sale brochures, annual reports and client references or endorsements, without prior written permission from the Owner. The Owner reserves the right to restrict or refuse access to any or all of its facilities.

1.4 SUBMITTALS:

- A. Submit in accordance with Division 1 and 23 submittal requirements.
- B. In addition to the requirements set forth in paragraph A above, the following shall be included in the shop drawing submittals including, but not limited to:
 - 1. Product Data: Submit manufacturer's technical product data sheets for each control device furnished, each data sheet shall be labeled indicating its control drawing descriptor and include the following:
 - a. indicating dimensions;
 - b. capacities;
 - c. performance characteristics;
 - d. electrical characteristics;
 - e. finishes of materials;
 - f. commissioning, installation instructions and start-up instructions.
 - 2. Valve, damper and well and tap schedule showing size, configuration, capacity and location of all equipment.
 - 3. Control system drawings containing pertinent data to provide a functional operating system and a sequence of operation.
 - 4. Detailed wiring diagrams.
 - 5. A floor plan of each area with a detailed new conduit/wiring layout shall be included. The plan shall indicate all conduit locations within $\pm 2'$ of actual installed location. All walls, doors and temperature control devices shall be accurately shown.
 - 6. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and all control devices. Identify all control points with labeling.
 - 7. Label each control device with setpoint or adjustable range of control. Provide a bill of materials with manufacturer's part number.
 - 8. Indicate all required point to point electrical wiring. Clearly differentiate between portions of wiring that are existing and portions to be field-installed.

9. Provide details of faces of control panels, including controls, instruments, and labeling.
 10. Include verbal description of sequence of operation and reference each device described by schematic symbol used.
 11. Provide a detailed listing of all software program code written for each system.
 12. Provide a point list with database input information to include a point name, address, base and span, action and other required information.
 13. Provide a detailed test plan and procedure for each HVAC system and for each type of terminal unit control including valves. The test plans shall fully define reporting methods, procedure, equipment utilized, milestones for the tests, identifying the simulation programs, and personnel. The test procedures shall be developed from the test plans and shall consist of instructions for test execution and evaluation. A test report form shall be developed for each point and sequence of operation. Commissioning procedures shall be provided for each HVAC system and for each type of terminal unit control system. The procedure shall include setpoint, prop. band, integral, derivative, mode constraints input, output settings, tuning procedures., etc.
- C. Submit manufacturer's installation instructions.
- D. Submittal data and shop drawings shall be prepared and submitted in the following formats:
1. All drawings prepared for the project shall be developed using the AutoCAD program, most current version, (or a CADD package capable of producing AutoCAD "DXF" compatible format files).
 2. All submittals data shall be the same size for any group of information and shall be in a three screw and post binder. (NO EXCEPTIONS). All the information shall be indexed and tabbed with reference to the specific section of these specifications.
 3. The format for different groups of submittal information are as follows:
 - a. Control drawings, building plans (including complete floor plans), schematics and system configurations shall be CAD prepared drawing, bound and indexed. Drawings that cannot represent the total information on an individual ANSI size B (11" x 17") drawing, i.e. a building plan, shall be noted with appropriate match lines, cross references and key plans.
 - b. Technical data, sequence of operations, material list, point lists, program listings, I/O schedules, operator's and programmer's manuals, etc. shall be type written, original product data sheets or CAD prepared drawings, ANSI size A or ANSI size B.
 4. Upon completion of the project and acceptance of systems the contractor shall provide to the Owner one set of hard copy as-built shop drawings and diskettes.
- E. Shop drawings shall include riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical will be allowed where appropriate.
- F. When the Architect/Engineer requires, the Contractor will resubmit with the corrected or additional submittal data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully reviewed.
- G. Contractor agrees that shop drawing submittals processed by the Architect/Engineer are not change orders, that the purpose of shop drawing submittals by the Contractor is to demonstrate to the Architect/Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. The Contractor shall be responsible for space requirements, configuration, performance,

changes in bases, supports, structural members and openings in structure, and other apparatus that may be affected by their use.

- H. Contractor further agrees that if deviations, discrepancies, or conflicts between shop drawing submittals and the contract documents in the form of design drawings and specifications are discovered either prior to or after shop drawing submittals are processed by the Architect/Engineer, the design drawings and specifications shall control and shall be followed. If alternates do not meet these requirements, it shall be this Contractor's responsibility to remove them and install material originally specified, at no cost to the Owner.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent any equipment damage, and to eliminate all dirt and moisture from equipment. Store all equipment and materials inside and protected from weather.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND CONTRACTORS:

- A. Subject to compliance with requirements, install one of the following systems:
 - 1. Allerton

2.2 SYSTEM SOFTWARE FEATURES:

- A. General
 - 1. All necessary software to form a complete operating system as described in this specification shall be provided.
 - 2. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

2.3 MATERIALS AND EQUIPMENT:

- A. General: The Contractor shall provide control products in the sizes and capacities indicated. The existing control system shall remain and be reused as is. Additional controllers, sensors, and devices which are required to make a complete control system shall be the responsibility of the controls contractor.
- B. Dampers shall be constructed of a minimum of 13 gauge galvanized steel frame, double piece, 22-gauge galvanized steel mechanically joined, zinc plated steel concealed linkage and blade pin, oil impregnated bearings, self-compensating stainless steel side seals and silicone blade seals. Leakage rates shall not exceed 10 cfm/ft² at 4" w.c. static pressure differential for a 24" x 24" damper. Provide extended shaft for proper and adequate actuator connection and operation. Damper blades shall not exceed 6" in height.

- C. Damper blade operation shall be as follows:

APPLICATION	OPERATION
Isolation/Shut-off Service	Parallel Blade

2.4 INPUTS:

- A. All input accuracies required by this section shall be end-to-end (from sensing point to BAS display). End-to-end accuracy includes all errors due to the sensor, transmitter, wiring and BAS signal measurement and A/D conversion.

2.5 ELECTRICAL MATERIALS:

- A. All wiring shall be installed in conduit. Where wiring is exposed in plenum locations (i.e. open cable tray, wiring shall be plenum rated.
- B. Conduit and Conductors: Types as indicated in Division 26 sized per Division 26 except for low-voltage twisted pair or single jacketed cable (1/2" minimum). All low voltage conductors shall be stranded 22 gauge copper minimum; twisted pair.
- C. Conduits shall not exceed 40% maximum fill for single conductor and jacketed cables.
- D. All communication cabling shall be shielded type.

2.6 END SWITCHES:

- A. All end switches shall be NEMA rated contacts and NEMA 4X enclosure, either SPDT, DPDT DPST as required to meet the sequence of operation, complete the points list and necessary interlocks or safeties control wiring. End switches shall be as manufactured by Cutler-Hammer or Allen-Bradley.
- B. All end switches shall be designed and configured to provide positive indication of a control device (i.e. damper or valve) position for the service intended.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. The Contractor shall install all equipment, control air piping/tubing, conduit and wiring parallel to building lines.
- B. All automatic control valves and control dampers furnished by the Temperature Control Contractor shall be installed under his supervision by the Mechanical Contractor.
- C. GENERAL INSTALLATION REQUIREMENTS:
1. Spare conductor capacity, equal to a minimum of (2) additional sensors shall be provided to each underfloor sensor and pendant type sensors.
 2. Wiring shall be installed in conduit throughout.
 3. Horizontal runs of conduit, trays, or wiring shall be hung from structural members using new supports, or where feasible, utilizing existing temperature control conduit. The

Contractor shall verify adequacy of existing systems and warrant these systems as if they were new. Single runs of conduit or wire shall be by clevis ring and all thread rod. Multiple runs shall be by "Trapeze" or "Unistrut" supports. "Plumber's Strap" shall not be allowed. Maximum distance between supports shall be per the NEC. Existing supports shall only be used upon written concurrence by the Architect, Engineer or Owner.

4. All vertical runs of conduit shall be through new core drills. Existing core drills may be used if approved by the Owner. The installation shall be supported above each floor penetration using clamps to "Unistrut".
5. All wire that enters or leaves a building structure shall be installed with lightning protection per NEC.
6. All wire terminations shall be with compression type round hole spade lugs under a pan head screw landing; Stay-Kon or equivalent. All wire splices shall be with compression type insulated splice connectors or properly sized "wire-nut" connectors. Hand twisted, soldered and/or taped terminations or splices are not acceptable.
7. Where wiring or conduit penetrates floors or walls, sleeves with bushings shall be provided for wires. The conduit or sleeve opening shall be sealed with fire proof packing so the smoke and fire rating of the wall or floor is maintained.
8. All the material installed under this contract must be mounted on, or supported from the building structure or supports furnished by this Contractor.

D. Control Wiring:

1. Run wiring in metallic conduit, tubing or raceways. Exceptions are as follows:
 - a. NEC Class 2 low voltage wiring where not exposed to view such as above suspended ceilings, in shafts, etc., may be run in cable (when approved by code authority).
 - b. Wiring enclosed in temperature control panels.
2. Where conduit is used, provide steel fittings.
3. Low Voltage Conductors: 18 gauge minimum, except 19 gauge may be used for home runs to central panels and 22 gauge minimum for resistance or thermistor sensing element connections.
4. Wire control interlocks and control panels, except one 120V power circuit to each temperature control panel shown on drawings and schedules shall be provided under Division 1.
5. All wiring shall comply with the requirements of local and national electrical codes.
6. Do not interlock alarms with starter switching to bypass alarm when equipment is manually disconnected.
7. All costs of controls, wiring conduit and associated labor shall be included in the temperature control bid. The control wiring shall be installed under the supervision of this Contractor.

3.2 INSTALLATION PRACTICES:

- A. The Contractor shall install and calibrate all Field Devices, sensors and transducers necessary for the complete operation of the I/O points described herein.

3.3 IDENTIFICATION:

- A. All control conduit and wiring shall be labeled.

3.4 LOCATIONS:

- A. All sensing devices and locations shall be located by the Contractor as shown on the submittal shop drawings with final review by the Engineer.
- B. Where existing walls are penetrated with conduit or piping, provide a fire stop assembly which meets or exceeds the original rating of the assembly. Refer to Division 23.
- C. Extreme care must be exercised while working in existing facilities and around operating equipment, particularly sensitive telephone switching and computer equipment. Close coordination with the Owner is required for the protection of this operating equipment from dust, dirt and construction material while maintaining the operational environment for the equipment. Under no circumstances shall the power or environmental requirements of the operating equipment be interrupted during the installation and check-out without submitting to the Architect, Owner and Engineer for approval.
- D. A detailed Method of Procedure (MOP) stating the steps to be taken, time schedule and impacted systems for the service interruption shall be submitted to the Architect for approval prior to beginning work. Refer to Division 1 and Division 23 for requirements.

3.5 CLEANUP:

- A. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned and all other areas shall be cleaned around equipment provided under this contract. Clean the exposed surfaces of tubing, hangers, and other exposed metal of all grease, plaster, dust, or other foreign materials.
- B. Upon final completion of work in an area, vacuum and/or damp wipe all finished room surfaces and furnishings. Use extreme care in cleaning around telephone switching and computer equipment and under no circumstances shall water or solvents be used around this equipment.
- C. At the completion of the work and at the end of each work day, remove from the building, the premises, and surrounding streets, etc., all rubbish and debris resulting from the operations and leave all equipment spaces absolutely clean and ready for use.

3.6 SOFTWARE, DATABASE AND GRAPHICS:

- A. Database Configuration: The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.
- B. Color Graphics: Unless otherwise directed by the Owner, the Contractor will provide color graphic displays for all systems which are specified with a sequence of operation, depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the Owner.

3.7 TEMPERATURE CONTROL DRAWINGS:

- A. Upon completion of project and after record drawings of the temperature controls have been prepared and reviewed, the Contractor shall provide one (1) complete set of temperature controls drawings at each temperature control panel. Each set of drawings shall be laminated in a plastic coating. The drawings shall consist of only those control functions associated with the specific control panel and any relevant or pertinent network interface information.

- B. The laminated drawings shall have a grommet connection attached to a metal cable or chain which is mechanically fastened to the temperature control cabinet.

3.8 START UP AND TESTING:

- A. Prior to Beneficial Use of the BAS, the Contractor shall supply to Architect/Engineer two (2) debugged printouts of all software entered into the BAS. Also supply all users programming and engineering manuals required to interpret the software. Included in the printouts, though not limited to, shall be the following:
 - 1. Point data base.
 - 2. All custom control programs written in the BAS control language.
 - 3. All parameters required for proper operation of BAS control and utility firmware such as start-stop routines, etc.
 - 4. Printouts or plotted detailed copies of the complete interactive system graphics.
- B. The software printout shall be fully documented for ease of interpretation by the Architect/Engineer and Owner, without assistance from the Contractor. English language descriptions shall be either integrated with or attached to the BAS printout. Specifically, the following shall be documented:
 - 1. All point (I/O and virtual) names.
 - 2. All BAS Programming Language commands, functions, syntax, operators, and reserved variables.
 - 3. Use of all BAS firmware.
 - 4. The intended actions, decisions, and calculations of each line or logical group of lines in the custom control program(s). Sequences of operation are not acceptable for use in this documentation requirement.
 - 5. Complete descriptions of and theories explaining all software and firmware algorithms. The algorithms to be described include, but are not limited to, PID, optimum start/stop, demand limiting, etc.
- C. Documentation that was supplied as part of the submittals need not be submitted at this time.
- D. Upon review of software, a point-to-point test of the BAS installation shall commence. The Contractor shall provide two men equipped with two-way communication and shall test actual field operation of each control and sensing point. This procedure shall occur during off hour periods. The purpose is to test the calibration, response, and action of every point. Any test equipment required to prove the proper operation of the BAS shall be provided by and operated by the Contractor. The Engineer and/Owner will be present to oversee, observe, and review the test. Demonstrate compliance that system functions per the Sequence of Operation.
 - 1. Upon review of the point-to-point demonstration, the Contractor shall start up the BAS by putting all controlled equipment in automatic and enabling software. Contractor shall commence final software and overall BAS hardware/software debugging.
 - 2. The point-to-point demonstration shall include any existing BAS equipment if it affects the operation of the equipment included under this contract.
 - 3. As a minimum, existing conditions shall be maintained during system changeover.
- E. Final acceptance of the BAS is contingent upon a hardware/software system test. All groups of points that yield a system of control shall be tested for compliance with the sequences of operation. Included in the test, but not limited to, shall be:
 - 1. BAS loop response. The Contractor shall supply a trend data output in graphical form showing the step response of each BAS loop. The test shall show the loop's response to

a change in set point which represents a change in the actuator position of at least 25% of its full range. The sampling rate of the trend shall be from one to three minutes depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that does not yield temperature control of + 0.2deg F or humidity control of + 3% RH shall require further tuning by the Contractor.

2. Interlocks and other sequences.
 3. BAS control under HVAC equipment failure.
 4. HVAC operation under BAS equipment failure.
 5. Battery backup.
 6. BAS control under power failure/restart.
 7. Reset schedules.
 8. BAS alarm reporting capability.
- F. A detailed test report as defined under Submittals shall be provided indicating its completion and proper system operation.
- G. The BAS will not be accepted as meeting the requirements of Beneficial Use until all tests described in this section have been performed to the satisfaction of both the Architect/Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor shall be exempt from the Beneficial Use requirements if requested in writing by the Contractor and concurred by the Owner and Architect/Engineer. Such tests shall be performed as part of the BAS warranty.
1. A typed written document stating that the system has been fully checked out on a point by point basis shall be submitted to the Architect/Engineer. All documentation associated with the checkout shall be included.

3.9 PROJECT RECORD DOCUMENTS:

- A. The Contractor shall be responsible for updating all existing Project Record Documents associated with the Scope of Work outlined in the Drawings and Specifications.
- B. Prior to final completion of the installation, prepare a complete set of record drawings on a clear and legible set of ANSI size 'B' (11" x 17") Mylar reproducible prints. The content, format and procedure of the submittal shall be as described by the General Conditions.
- C. The record drawings shall document the complete existing control system. This includes all mechanical equipment in work area which has automatic control.

3.10 WARRANTY:

- A. The Warranty period shall begin on the date of beneficial use completion as authorized by the Architect/Engineer and Owner in writing. Beneficial use shall not occur before the Contractor has performed the tests required. With these requirements met, beneficial use shall not occur until, in the opinion of the Architect/Engineer, the BAS is sufficiently complete to be utilized for the purposes for which it is intended.
 1. The warranty start date shall not begin until all phases of the Project are complete, i.e., the Project shall have a single warranty start date.
- B. The BAS system shall be guaranteed to be free from defects in material and workmanship and in software design and operation for a period of the warranty after completion of the contract. The Contractor shall provide the necessary skills, labor, and parts to assure the proper

operation of, and to provide all required current and preventive maintenance. This warranty shall become effective starting the date of Beneficial Use completion.

1. The hardware warranty shall include all equipment which has been purchased by the Contractor. The existing hardware is not subject to the warranty requirements.
 2. All software work completed by the Contractor, associated with existing hardware, is subject to the warranty requirements outlined herein.
 3. The Contractor shall respond to all calls during the warranty period for all problems or questions experienced in the operation of the installed equipment and shall take steps to correct any deficiencies that may exist.
 4. The response time to any problems shall be four (4) hours maximum 24 hours per day, 7 days per week. Corrective action, temporary or permanent shall be made within one business day.
- C. The Contractor shall maintain a backup of all BAS software installed in the system. The backup shall be updated monthly or whenever a change to the software is made. A reload of backup software into the system shall be performed by the Contractor immediately upon notification by the Owner. The reload shall be free of charge unless it is due to a power failure of a duration longer than the battery backup.
- D. The Contractor shall optimize all control software to assure acceptable operating and space conditions, and peak energy efficiency.
- E. At the end of the warranty period, the Contractor shall supply updated copies of the latest versions of all Project Record Documentation. This includes final updated drawings, software documentation and magnetic media backups that include all changes that have been made to the system during the warranty period.

END OF SECTION 23 09 00

SECTION 23 0993

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. **Note: The majority of the sequences below are existing, shown un-bolded. All new/revised sequencing is shown bolded.**
- B. Sequence of operation is hereby defined as the manner and method by which controls function. Requirements for each type of control system operation are specified in this section.
- C. Operating equipment, devices, and system components required for control systems are specified in other Division 23 Controls' sections of these specifications.
- D. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS:

- A. Provide control systems consisting of thermostats, control valves, dampers, operators, indicating devices, interface equipment, and other apparatus required to operate mechanical system and to perform functions specified.
- B. Provide necessary materials and field work necessary to connect control components factory supplied as part of equipment controlled, unless specified otherwise. Generally, self-contained valves, filter gauges, liquid level controllers and similar instruments, are not to be installed under this section.
- C. Unless specified otherwise, provide fully proportional components.
- D. Provide all necessary relays and signal boosters to make the system a full and operable system as required by the sequence of operation.

PART 3 – SEQUENCE OF OPERATION

3.1 TERMINAL UNITS' CONTROL SEQUENCES:

- A. Hot Water Heating Finned Tube/Baseboard: Provide wall mounted thermostat to automatically modulate a normally open two-way control valve to maintain the thermostat setting. In rooms, which also have a terminal-heating coil, thermostat shall sequence the FTR valve with the heating coil valve to maintain stat set temperature. The perimeter finned tube shall be part of night set back sequence to maintain 55 degree space temperature for the hours of 10:00 p.m. to 6:00 a.m. (adjustable). During the 1 hour warm up period the finned tube radiator valve shall be full open until set point is reached. During night set back, utilize finned tube radiators as the primary source of heat. Valves shall be two position.
- B. Hot water Unit Heater: Provide wall-mounted thermostat to automatically modulate a normally/open/two way control valve and cycle the fan motor to maintain the thermostat setting. Valves shall be two position.

- C. Hot Water Cabinet Unit Heaters: Provide wall-mounted thermostat to automatically modulate a normally/open/two way control valve and cycle the fan motor to maintain the thermostat setting. Valves shall be two position.

3.2 TERMINAL BOX CONTROL SEQUENCES:

- A. Variable Air Volume with Reheat: The thermostat shall control the damper operator on the variable volume, pressure independent terminal box. On a drop in room temperature below thermostat set point, the thermostat shall modulate down to the airflow minimum scheduled air quantity to satisfy thermostat cooling set point. On further drop in room temperature below thermostat heating set point, the thermostat shall modulate the reheat coil normally open two-way control valve and increase the air flow to satisfy thermostat set point. On rise in temperature above the thermostat set point, the thermostat shall close the normally open two-way control valve and modulate the airflow to maximum scheduled air quantity. Provide discharge air temperature sensors downstream of every VAV box and report temperature to BAS. Upon signal from kitchen hood EF's, reset the VAV minimum's to the higher amounts as shown on terminal box schedule.
- B. Variable Air Volume with Reheat Interlocked with Finned Tube Radiation: The thermostat shall control the damper operator on the variable volume, pressure independent terminal box. On a drop in temperature below cooling set point, the thermostat shall modulate the airflow to minimum scheduled air quantity to satisfy cooling set point. On further drop in temperature below heating set point, the thermostat shall modulate the VAV box reheat normally open two-way heating control valve. Upon further drop in temperature the finned tube radiation normally open control valve to satisfy heating set point. Provide discharge air temperature sensors downstream of every VAV box and report temperature to BAS. Upon signal from kitchen hood EF's, reset the VAV minimum's to the higher amounts as shown on terminal box schedule.
- C. For both sequences above, the building will have a night setback temperature set point of 55 degrees (adjustable). This shall be a room by room (zone by zone) basis. During night setback, the finned tube radiators shall be the primary source of heat to keep the air handler off.
- D. Morning warm-up sequence shall be provided so that the VAV boxes go to full heating during this 1 hour period from 6:00 am to 7:00 am (adjustable). During this time, the VAV shall open to full cooling cfm with 75 degree entering and approximately 88 degree leaving air temperature.

3.3 AIR HANDLER CONTROL SEQUENCES:

- A. Air Handling Unit AHU 1 & 2:
 - 1. **During occupied operation**, the 2 AHU's are intended to operate in parallel and control equally to maintain supply air static pressure.
 - 2. The air-handling unit shall be controlled by a local DDC control panel interfaced with the Building Automation System. The system shall be complete with access through local or remote terminals.
 - 3. The air handler shall be integrated to the night set back temperature sequence so that it remains off line between 10:00 pm and 6:00 am (adjustable) unless the average space temperature drops below 50 degree's (adjustable). The primary source of heat during night set back shall be the finned tube radiators.
 - 4. The morning warm up shall include raising the discharge air temperature from the AHU to 75 degree's (adjustable). During morning warm up, the outside air and relief air

dampers shall be closed. **The primary source of heat during warm-up shall be the return air preheat coil. Refrigerant (heat pump) coil shall only be used if the discharge air temperature set-point is not achieved after 15 minutes (adj.).**

5. If the outside air temperature drops below -25 degrees (adjustable), the night set back sequence shall be overridden to allow the building temperature to increase and stay warm until the outside air temperature rises above this critical temperature.
6. Whenever air handling unit air fan is started, the outside and exhaust air dampers shall open to their minimum positions and the supply and return/exhaust shall cycle on through an interlock.
7. The supply fan speed shall be modulated by the duct static pressure controller through the local control panel and the variable frequency drive.
8. The return fan speed shall be modulated through the local control panel and variable frequency drive to maintain a fixed (adjustable) air flow differential between supply and return air quantities as sensed by the supply and return air flow measuring stations. The differential of supply versus return shall be based on the status signals from all exhaust fans within the building. Building DDC system shall determine sum of exhaust fan cfm's and report the number to the AHU controllers.
9. Relief air dampers shall be modulated to maintain the building at 0.02 in-wc (adjustable) through static pressure sensors.
 - a. Coordinate with test and balance contractor to optimize the offset to provide for proper building pressurization.
10. Economizer Control: Below an outside air temperature of 75°F (adjustable), the economizer outside air and return air dampers shall modulate to maintain the discharge air setpoint as determined by the reset schedule.
11. Economizer Control: Above an outside air temperature greater than the temperature of the return air, the dampers shall set minimum outside air conditions.
12. Under non-economizer conditions, the minimum outside air damper shall modulate to maintain the constant outside air quantity as calculated based on the equation below and as sensed by the outside airflow measuring station. The return air damper shall be set (balanced) to its maximum position to create the proper pressure drop necessary to ensure a negative outside air plenum.
 - a. $OA = 14,000 \text{ cfm } \underline{OR} (BL + EF)$, whichever is greater, where:
 - b. BL = Building leakage (Determined using #9 above)
 - c. EF = Σ of exhaust fan CFM's (Determined using #8 above)
 - d. Note: All CFM's are totals, and need to be split between the AHU's.

If the minimum outside air damper is full open, and the relief damper is fully closed, and the building pressure drops below setpoint, the economizer outside air damper shall open to minimum position (total outside air quantity is no longer measured). If the relief damper opens for more than 5 minutes (adj.), revert sequence back to minimum outside air control.

13. Provide a discharge air reset schedule to reset up to 65 degree's during normal operation based on outside air temperature so that at 20 degree outside air temperature and below the discharge is 65 degrees and above 40 degrees the discharge air shall be

55 degrees with a sliding scale between 20 and 40 degrees (adjustable).

14. The system shall reset the duct static pressure setpoint based on the position of the most open VAV box. The duct static setpoint shall continue to reset until the most open VAV box is at 90% open. As the most open VAV box continues to open beyond the 90% mark, the duct static setpoint shall begin to move up to compensate for the critical box.
15. On detection of smoke from the unit mounted smoke detectors or on signal from the fire alarm system, the supply and return fans shall cycle off and the outside air, return air and exhaust air dampers shall close, and an alarm shall be sent to the BAS.
16. On detection of high static pressure in the supply air or return air ductwork, the supply and return fans shall cycle off, the outside air and exhaust air dampers shall close 100% the return air damper shall open 100% and an alarm shall be sent to BAS.
17. Per sequence in #8 above, the return fan differential is as follows:
 - a. $RF = (SF - BL - EF)$, where:
 - b. RF = Return fan CFM (Verified by return air flow monitor)
 - c. SF = Supply fan CFM (From supply air flow monitor)
 - d. BL = Building leakage (Determined using #9 above)
 - e. EF = Σ of exhaust fan CFM's (Determined using #8 above)
 - f. Note: All CFM's are totals, and need to be split between the AHU's.
18. Preheat coil sequence:
 - a. The preheat coil shall enable upon an outside air temperature below 20 degrees (adjustable).
 - b. 2. The preheat coil control valve shall modulate to achieve a mixed air temperature set point of 35 degree's.
 - c. 3. A new control valve and mixed air temperature sensor will be required for connection to the ATS BAS for each air handler.
19. **In an effort to help improve energy efficiency of the building's HVAC system, motorized isolation dampers are to be installed in the supply air streams served by AHU-1 and AHU-2. During unoccupied periods, the following sequence shall be implemented to isolate the AHU's and allow improved system turn-down:**
 - a. **As part of the factory control package, AHU-2 is slave to AHU-1 (AHU-1 is lead AHU). During unoccupied periods (as determined by the BAS), the lead and lag AHU shall be disabled and the associated motorized damper shall close. The lead AHU motorized damper shall open upon a call for unoccupied heating, and the AHU shall operate to maintain duct static pressure per the above (existing) sequence. All other AHU components shall also operate per the existing unoccupied control sequence during unoccupied periods. When AHU-1 fails, AHU-2 shall take over as lead. A hardwire interlock is required between the motorized damper and associated AHU. Motorized damper shall prove-open before starting fans.**
20. **Morning Cool Down: If there was a call for cooling within the last 24 hours (adj.), and the average indoor temperature is 3 deg F. or more above set-point, and the outside air temperature is lower than the average indoor temperature, implement the following sequence:**

- a. **1 hour (adj.) before start of building occupancy, primary AHU shall deliver 100% outside air to the building, in-lieu of heat pump operation. When the average space temperature reaches set-point, unit shall return to unoccupied mode.**
- b. **Building space temperatures shall be allowed to “float” after morning warmup or cooldown sequences – bring heat pump compressors on slowly to help avoid high electric demand charge. Allow each stage of cooling to operate for 15 minutes (adj.) prior to enabling the next stage. Innovent and the DDC Contractor shall work with the Owner to determine optimum staging schedule.**

3.4 EXHAUST/TRANSFER FANS:

- A. EF-1: Exhaust air fan(s) shall run continuously with manual ON/OFF control through the Building Management System. The exhaust fan shall be connected to the building night set back schedule to be off during the hours from 10:00 p.m. to 6:00 a.m.
- B. EF-2, 3, 4: Kitchen exhaust fan shall operate based on any one of the switches at the hoods. Once activated, the status signal shall be sent to the BAS and reset the associated supply VAV box to the increased amount for make-up air to hood.
- C. EF-5, 6: Exhaust air fan(s) shall be interlocked with the space light switch and shall run only when light switch is into ON position.
- D. EF-7: Exhaust air fan(s) shall run continuously at lowest VFD setting. Upon detection of refrigerant leakage, fan shall ramp up to full speed and an alarm shall be sent to the Building Management System.
- E. TF-1, 2, 3, 4, 5: Transfer air fan shall operate when line-voltage thermostat senses a space temperature of 80 deg F (adj.) or above.

3.5 BUILDING HOT WATER BOILER B-1 AND WATER SOURCE HEAT PUMP CONTROL:

- A. The water source heat pump is the first stage of heat for the building reheat and perimeter heat system. If the heat pump is at full capacity, and not able to maintain setpoint, enable the boiler. If the heat pump is failed, enable the boiler to maintain setpoint. The hot water system shall be enabled when (2) zones (adj.) call for heat.
- B. The hot water boiler/heat pump and its respective primary pump will be enabled from the DDC system. The boiler/heat pump will be sequenced on and off or opened and closed from supply water temperature as required to maintain 130°F (adjustable) supply water temperature. The boiler's internal factory mounted controls will control the firing of the boiler. The heat pump internal factory controls will control the compressor staging. Whenever the boiler/heat pump is shut off, its respective pump shall disable and whenever the boiler/heat pump is activated, its respective pump shall open.
- C. The hot water pumps will be controlled by the DDC panel as a lead lag scenario. If the lead pump fails, the lag pump will be started from differential pressure switch located between the discharge and suction of each pump. The DDC panel will generate an alarm if any of the two running pumps stop.
- D. One secondary pump will be started anytime either the boiler or heat pump are activated and it's VFD shall control to the system DP located near the end of the loop.
- E. Building hot water supply and return temperatures will be indicated at the BAS.

- F. Geothermal water supply and return temperatures will be indicated at the BAS. These shall be trended to determine if the ground temperature changes.
 - G. The Geothermal water pumps shall be enabled at any time there is a call for heating or cooling as signaled from the AHU's and/or heating water heat pump. Initially (until Bristol is on line) the pumps shall run as a Lead/Lag scenario and the speed of the pump shall be based on system differential pressure. If the lead pump fails, the lag pump shall enable and an alarm sent to the BAS. The lead pump shall switch on a monthly basis to provide equal run time for both pumps.
 - H. The heating boiler shall be cycled on a weekly basis to exercise the boiler. The boiler shall be run once a week for 2 hours (adjustable).
 - I. There shall be a push button emergency shutdown of the boiler. The push button shall be wired to the safety circuit connection at the boiler.
 - 1. **Morning warmup: The condensing boiler shall be lead hot water source during morning warmup cycle, in-lieu of heat pump operation. This will help avoid high electric demand charge during high-demand periods. Upon boiler failure or in the event that the boiler cannot maintain HWS temperature, the heat pumps shall cycle-on to supplement. The reverse sequence shall occur during normal operation (heat pumps to be primary source of heat, boilers to be backup).**
- 3.6 REFRIGERATION ROOM VENTILATION CONTROL:
- A. The exhaust air fan shall start and the outside air damper shall open any time the chiller/heat pump is activated and shall run continuously until chiller is deactivated. Fan differential pressure switch will be used for proof of status of fan.
 - B. A refrigeration detection system shall be provided to increase the exhaust air to higher level and send an alarm to the audible and visual indicator at the exterior of the room doors. If refrigerant is detected, the heat pump and boiler shall be disabled, audible and visual alarms activate and an alarm sent to the BAS. A push button emergency shut down shall be provided for occupant controlled shut down of the chiller/heat pump and increase the exhaust amount.
- 3.7 MISCELLANEOUS ITEMS
- A. The Following status and alarms shall be reported to the BAS:
 - 1. Elevator sump pump run alarm.
 - 2. Domestic hot water pump status/alarm.
 - 3. Domestic hot water heater alarm.
 - 4. Cabinet heater, Fan coil units (not I.T. rooms) alarms.
 - 5. Provider CO2 monitors for the Auditorium and the Dining area. CO2 monitor shall send an alarm to the BAS if the CO2 levels rise above 900 ppm. The associated VAV box shall increase airflow to the space until the CO2 level drops below the alarm point. The building operator may adjust the outside air position.

6. Provide a separate temperature sensor for each I.T. room that contains a split system air conditioner. This temperature shall alarm the BAS if the temperature rises above 80 degrees.

3.8 DDC OBJECT TYPE SUMMARY:

- A. Provide all database generation.
- B. Displays
 1. System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air temperature indication on all system displays associated with economizer cycles.
- C. Run Time Totalization
 1. At a minimum, run time totalization shall be incorporated for each monitored supply fan, return fan, exhaust fan, hot water and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.
- D. Trendlog
 1. All binary and analog object types (including zones) shall have the capability to be automatically trended.
- E. Alarm
 1. All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.
- F. Database Save
 1. Provide backup database for all standalone application controllers on disk.

3.9 FIELD SERVICES:

- A. Prepare and start logic control system under provisions of this section.
- B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation.
- C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.
- D. Provide owner's representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.10 TRAINING:

- A. Provide application engineer to instruct owner in operation of systems and equipment.
- B. Provide system operator's training to include (but not be limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data,

execution of commands and request of logs. Provide this training to a minimum of three persons.

- C. Provide on-site training above as required, up to 16 hours as part of this contract.
- D. Provide tuition for at least one individual to attend for a one-week factory training class. If applicable, costs for travel, lodging and meals will be the responsibility of the owner.

3.11 DEMONSTRATION:

- A. Demonstrate complete operating system to owner's representative.
- B. Provide certificate stating that control system has been tested and adjusted for proper operation.

END OF SECTION