

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", and "2015 International Fire Code" as published by the International Conference of Building Officials.
 4. "2017 Idaho Plumbing Code." as published by the International Association of Plumbing and Mechanical Officials.
 5. "National Electrical Code" as published by the National Fire Protection Association.
 6. "2015 International Energy Conservation Code".
- C. Identification: Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when Project is turned over to Owner.

1.6 INSPECTIONS AND PERMITS

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

1.7 ADDITIONAL WORK:

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

PART 2 - PRODUCTS FOR COMMON HVAC REQUIREMENTS

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

- C. Insure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents.
 - 1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.
 - 2. If non-specified equipment is used and it will not fit job site conditions, this Contractor assumes responsibility for replacement with items named in Contract Documents.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters,



motors, control components, and to clear openings of doors and access panels.

3.4 STORAGE AND PROTECTION OF MATERIALS:

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

3.5 EXCAVATION AND BACKFILL

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

3.6 COOPERATION

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

3.7 SUPERVISION

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

3.8 INSTALLATION CHECK:

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



written report certifying the following:

1. Equipment has been properly installed and lubricated.
2. Equipment is in accurate alignment.
3. Equipment is free from any undue stress imposed by connecting piping or anchor bolts.
4. Equipment has been operated under full load conditions.
5. Equipment operated satisfactorily.

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

3.9 CLEANING EQUIPMENT AND PREMISES

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

3.10 TESTS

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

3.11 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 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Furnish and install identification of equipment and piping as described in Contract Documents.
- B. Mechanical Contractor shall touch-up equipment where factory paint has been damaged. Repaint entire item where more than 20 percent of the surface is involved.
- C. Primary painting of walls, ceilings, ductwork, piping and plenums is covered in the general painting section of these Contract Documents.

PART 2 - PRODUCTS**2.1 PAINT**

- A. Benjamin Moore Impervo or equivalent by Paint Manufacturer approved in Section 09 900.
- B. Use appropriate primer.

2.2 LABELS

- A. Black Formica with white reveal on engraving.

2.3 CODED BANDS

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

2.4 PIPE IDENTIFICATION

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

2.5 EQUIPMENT IDENTIFICATION

- A. Provide an engraved plastic plate for each piece of equipment stating the name of the item, symbol number, area served, and capacity. Label all control components with plastic embossed mechanically attached labels. Sample:
 - 1. Supply Fan SF-1 - North Classrooms
 - 2. 10,000 CFM @ 2.5"



2.6 VALVE IDENTIFICATION

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

PART 3 - EXECUTION

3.1 APPLICATION

- A. Engraved Plates:
 - 1. Identify thermostats and control panels in mechanical rooms, furnaces, boilers and hot water heating specialties, duct furnaces, air handling units, electric duct heaters, and condensing units with following data engraved and fastened to equipment with screws –
 - a. Equipment mark noted on Drawings (i.e., SF-1)
 - b. Area served (i.e., North Classrooms)
 - c. Capacity (10,000 CFM @ 2.5)
- B. Stenciling:
 - 1. Locate identifying legends and directional arrows at following points on each piping system –
 - a. Adjacent to each item of equipment and special fitting.
 - b. At point of entry and exit where piping goes through wall.
 - c. On each riser and junction.
 - d. Every 50 feet on long continuous lines.
 - 2. Heat Pump, Cooling Tower, Gas, & Valve Identification –
 - a. Identify specific pipe contents by stenciling pipe with written legend and placing of arrows to indicate direction of flow.

C. Painting:

- 1. Background Color - Provide by continuous painting of piping.

Symbol	Name	Color
NG	Natural Gas	Yellow
FS	Fire Sprinkler	Red
HPS	Heat Pump Supply	Green
HPR	Heat Pump Return	Green
CTS	Cooling Tower Supply	Blue
CTR	Cooling Tower Return	Blue

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

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

1.3 SUBMITTALS

- A. Agency Data:
1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below. The firm or individuals performing the work herein specified may not be the installing firm.
- B. Engineer and Technicians Data:
1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.
- C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.
- D. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.
- E. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below.
1. Draft Reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
 2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 4 complete sets of final reports.

3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
 - a. General Information and Summary
 - b. Air Systems
 - c. Temperature Control System Verification.
- F. Report Contents: Provide the following minimum information, forms, and data:
1. General information and Summary: Inside cover sheet to identify testing, adjusting, balancing agency, Contractor, Owner, Engineer, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentation used for the procedures along with the instrument calibration sheet.
 2. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form. The report shall contain the following information, and all other data resulting from the testing, adjusting, and balancing work:
 - a. All nameplate and specification data for all air handling equipment and motors.
 - b. Actual metered running amperage for each phase of each motor on all pumps and air handling equipment.
 - c. Actual metered voltage at air handling equipment (phase-to-phase for all phases).
 - d. Fan RPM for each piece of air handling equipment.
 - e. Total actual CFM being handled by each piece of air handling equipment.
 - f. Actual CFM of systems by rooms.
 3. Certify that all smoke and fire dampers operate properly and can be reset under actual system operating conditions.
- G. Calibration Reports:
1. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.4 CERTIFICATION

- A. Agency Qualifications:
1. Employ the services of a certified testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement, and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, recording and reporting the results, and operation of all systems to demonstrate satisfactory performance to the owner.
 2. The testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one person certified by NEBB or AABC as a Test and Balance supervisor, and a registered professional mechanical engineer, licensed in the state where the work will be performed.
- B. Codes and Standard:
1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
 2. AABC: "National Standards for Total System Balance."



3. ASHRAE: ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.

1.5 PROJECT CONDITIONS

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

1.6 SEQUENCING AND SCHEDULING

- A. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems within +10% to -5% of contract requirements.
- B. The report shall be approved by the Engineer. Test and balance shall be performed prior to substantial completion.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

- A. Before operating the system, perform these steps.
 1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
 2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
 3. Compare design to installed equipment and field installations.
 4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
 5. Check filters for cleanliness and to determine if they are the type specified.
 6. Check dampers (both volume and fire) for correct and locked position. Check automatic operating and safety controls and devices to determine that they are properly connected, functioning, and at proper operating setpoint.
 7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross-check with required fan volumes.
 8. Determine best locations in main and branch ductwork for most accurate duct traverses.
 9. Place outlet dampers in the full open position.
 10. Prepare schematic diagrams of system "As-Built" ductwork and piping layouts to facilitate reporting.
 11. Lubricate all motors and bearings.
 12. Check fan belt tension.
 13. Check fan rotation.

3.2 KITCHEN HOOD

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

3.3 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:



1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.4 MEASUREMENTS

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.
- C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5%. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- G. Take all readings with the eye at the level of the indicated value to prevent parallax.

- H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- I. Take measurements in the system where best suited to the task.

3.5 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards. Balancing of the air systems and hydronic systems shall be achieved by adjusting the automatic controls, balancing valves, dampers, air terminal devices, and the fan/motor drives within each system.
- B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- C. Patch insulation, ductwork, and housings, using materials identical to those removed.
- D. Seal ducts and piping, and test for and repair leaks.
- E. Seal insulation to re-establish integrity of the vapor barrier.
- F. Adjust timing relays of environmental equipment motor reduced voltage starters to the optimum time period for the motor to come up to the maximum reduced voltage speed and then transition to the full voltage speed to prevent damage to motor, and to limit starting current spike to the lowest possible and practical.
- G. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- H. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.6 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.
- C. Report shall be certified and stamped by a registered professional mechanical engineer employed by the agency and licensed in the state where the work will be performed.
- D. Engineer is to provide a floor plan and test and balance contractor to include the plan in test and balance report and identify actual cfm on drawing or number the diffusers to match report.

3.7 DEMONSTRATION

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

END OF SECTION 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. Heat Pump Piping Insulation
 3. Boilers, Tanks, Headers, and Breechings
 4. Refrigerant Piping
 5. Fire Stopping

1.3 QUALITY ASSURANCE

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

END OF SECTION 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 0715 – HEAT PUMP PIPING INSULATION**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

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

PART 2 - PRODUCTS**2.1 MATERIAL**

- A. 6 lb./cu.ft. heavy density fiberglass with fire retardant vapor barrier jacket with self sealing laps. Thickness shall be 1-1/2 inches on heating supply and return lines.
- B. Approved Manufacturers:
 - 1. Owens-Corning Fiberglass heavy density with ASJ-SSL jacket
 - 2. Equals by Johns-Manville or CTM.
 - 3. Zeston covers for valves and fittings.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Pipes:
 - 1. Install in accordance with manufacturer's directions on clean dry pipes.
 - 2. Butt joints firmly together.
 - 3. Seal vapor barrier longitudinal seam overlap with vapor barrier adhesive.
 - 4. Wrap butt joints with four inch strip of vapor barrier jacket material cemented with vapor barrier adhesive.
 - 5. Finish with bands applied at mid-section and at each end of insulation.
- B. Valves & Fittings:
 - 1. Insulate and finish by one of following methods:
 - a. With hydraulic setting insulating cement, or equal, to thickness equal to adjoining pipe insulation.
 - b. With segments of molded insulation securely wired in place.
 - c. With prefabricated covers made from molded pipe insulation finished with vapor barrier adhesive.
 - d. Zeston covers and factory applied insulation diapers.
 - 2. Finish fittings and valves with four ounce canvas and coat with vapor barrier adhesive or Zeston covers.
- C. Piping located outdoors and exposed to the weather shall be insulated as indicated above except the thickness shall be determined according to the worst weather extremes expected. The insulation shall then be protected with one of the following weatherproof finishes as indicated on contract drawings:
 - 1. Metal jacketing shall be 0.016" (0.4 mm) minimum aluminum or stainless steel with moisture barrier, secured in accordance with the jacket manufacturer's recommendations.



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

END OF SECTION 23 0715

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.

1.3 SYSTEM DESCRIPTION

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

1.4 RATINGS:

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

PART 2 - PRODUCTS**2.1 DUCT LINER**

- A. One inch thick, 1-1/2 lb density fiberglass, factory edge coated.
- B. Duct lining materials are to meet the requirements of UL 181 for mold, humidity, and erosion resistance.
- C. Approved Manufacturers:
 - 1. Certainteed Ultralite 150 Certa Edge Coat
 - 2. Knauf - Type M
 - 3. Manville - Lina-Coustic
 - 4. Owen Corning Fiberglas - Aeroflex

2.2 ADHESIVE

- A. Water Base Type:
 - 1. Cain - Hydrotak
 - 2. Duro Dyne - WSA
 - 3. Kingco - 10-568
 - 4. Miracle - PF-101
 - 5. Mon-Eco - 22-67
 - 6. Techno Adhesive - 133
- B. Solvent Base (non-flammable) Type:
 - 1. Cain - Safetak
 - 2. Duro Dyne - FPG



3. Kingco - 15-137
4. Miracle - PF-91
5. Mon-Eco - 22-24
6. Techno Adhesive - 'Non-Flam' 106

C. Solvent Base (flammable) Type:

1. Cain - HV200
2. Duro Dyne - MPG
3. Kingco - 15-146
4. Miracle - PF-96
5. Mon-Eco - 22-22
6. Techno Adhesive - 'Flammable' 106

2.3 FASTENERS

- A. Adhesively secured fasteners not allowed.
- B. Approved Manufacturers:
 1. AGM Industries Inc - "DynaPoint" Series DD-9 pin
 2. Cain
 3. Duro Dyne
 4. Omark dished head "Insul-Pins"
 5. Grip nails may be used if each nail is installed by "Grip Nail Air Hammer" or by "Automatic Fastener Equipment" in accordance with Manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous 100% coat of adhesive and with 3/4 inch long mechanical fasteners 12 inches on center maximum unless detailed otherwise on Drawings. Pin all duct liner.
- B. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom sections of insulation shall overlap sides. If liner is all one-piece, folded corners shall be tight against metal. Ends shall butt tightly together.
- C. In casings and plenums further contain insulation with wire mesh.

3.2 FIELD QUALITY CONTROL

- A. If insulation is installed without longitudinal and end joints butted together, installation will be rejected, and work removed and replaced with work that conforms to this Specification.
- B. Insulation shall be installed in accordance with Duct Liner Application Standard SMACNA Manual 15.

3.3 ADJUSTING, CLEANING

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

END OF SECTION 23 0718

SECTION 23 0722 – FIRE PROTECTION DUCT WRAP**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Furnish and install insulation on grease and air ducts requiring UL and NFPA fire protection within confines of building as described in Contract Documents.

PART 2 - PRODUCTS**2.1 MATERIAL**

- A. Composition & Materials:
 - 1. The PYROSCAT FP Duct Wrap system is composed of two layers of 1 ½” thick refractory grade fibrous fire barrier material designed to withstand temperatures in excess of 2000F. The PYROSCAT FP Duct Wrap comes in three forms, aluminum foil laminated on both sides, aluminum foil laminated on one side, and no foil lamination. When the system is used in floor or wall penetrations, the PYROSCAT FP Duct Wrap is used in conjunction with Nelson FSP Fire Stop Putty.
- B. Applicable Standards and Codes
 - 1. PYROSCAT FP Duct Wrap meets the requirements of UL YJET for Grease Duct Enclosures in accordance with SBCCI Acceptance Criteria. This standard requires that the system meet the following: 1) an external full scale fire test for 1 and/or 2 Hr Fire Resistance duct enclosures and through penetrations per UL 263/ASTM E-119 with hose stream; 2) minimum temperature rise standards in the 2000° Abnormal Temperature Test as detailed in “UL Subject 1978 Proposed First Edition of the Standard for Grease Ducts”, 3) Surface Burning Characteristics per UL 723 (ASTM E-84 with FSI not over 25 and SDI not over 50. All testing for acceptance has been conducted at Underwriters Laboratories located in Northbrook, IL.
 - 2. PYROSCAT FP Duct Wrap also meets all applicable requirements of NFPA 96 “Standard for Vent. Control and Fire Protection of Commercial Cooking Operations”.
 - 3. Duct wrap shall be listed to AC-100/ASTM 2336 test standard for grease duct wrap. Also duct wrap shall comply with latest ICC Evaluation Services Report and 2015 IMC.

2.2 MANUFACTURER

- A. PYROSCAT FP Duct Wrap by Premier Refractories.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Prior to use or concealment of any portion of the grease duct system, a leakage test shall be performed. This test will be required to be provided to the HVAC Inspector prior to concealment of the Grease Duct.
- B. PYROSCAT FP Duct Wrap shall be applied by qualified contractors. The fire barrier material is



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

END OF SECTION 23 0722

SECTION 23 0800 – FIRE STOPPING**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS**2.1 MANUFACTURED UNITS**

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

PART 3 - EXECUTION**3.1 INSTALLATION**

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

END OF SECTION 23 0800

**SECTION 23 0953 - BUILDING ENERGY MANAGEMENT-TEMPERATURE CONTROL SYSTEMS-
BMS (HONEYWELL WEBS N4)****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Furnish all labor, materials, equipment, tools and services required to fully complete the Building Energy Management & Temperature Control Systems (BMS) work as is indicated on the drawings and/or specified herein including, but not limited to, the following described items.
- B. (BMS) utilizing Direct Digital Controls (DDC) as shown on the drawings and as described herein. Drawings are diagrammatic only.
- C. 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.
- D. The Owner shall be the named license holder of all software associated, with administration access to functions and folders, usernames, passwords and password phrases, incremental work on the project(s) and will be provided with Superuser Passwords and copies of Stations.
- E. System Provider:
 - 1. Controls system provider for this project, shall be Niagara 4 certified and responsible for the control work described herein. Including material, labor, hardware, software, warranty, etc. including cost of system, design, programming, software setup and installation including wire and conduit (See Part 3 Execution of the Specification), checkout, test and demonstration.
- F. All equipment and work performed with the BMS shall comply to and seamlessly integrate with the graphical interface as installed by the primary control contractor.

1.2 SYSTEM DESCRIPTION

- A. The Building Management System shall be comprised of a network of interoperable, stand-alone digital controllers communicating via Bacnet, or FOXS communication protocols to a Niagara 4 Jace. Temperature Control System products shall be manufactured by Honeywell.
- B. The BMS shall be comprised of JACE or Controllers within the facility. The BMS shall connect to the owner's local or wide area network, and supervisor installed on temple server 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 and a Communication Software (Windows Remote Desktop) if applicable. Each BMS shall communicate to BACnet field controllers and other open protocol systems/devices provided under Division 25 or Division 26. The BMS as provided in this Division shall be based on the Niagara 4 Framework.
- C. BACnet controllers shall be BTL listed.

1.3 SUBMITTAL

- A. Digital copies in pdf format, of 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, actuators, sensors, switches, 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. The Contractor may use CAD copies of the CAD contract drawings as a place to begin, but the final submittals are to become the product of the Contractor's effort leading to a final system configuration.

- B. 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. The Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN).
- C. Submittal shall also include a complete point list of all physical points to be connected to the BMS. Contractor shall provide necessary point lists, protocol documentation, and factory support information for systems provided in their respective divisions but integrated into the BMS.
- D. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and Owner/SPD. The Graphical User Interface shall comply with the SPD Graphics Guidelines.
- E. Submittal shall include
 - 1. Updated and adapted sequences of controls provided by this contractor. The sequence of controls contained herein are summary sequences which shall be adapted by this contractor to achieve project set-point temperatures, pressures, humidity levels and air quality. This contractor shall be responsible to adapt the controls programming as required to achieve the project specific needs.
 - 2. Software design data including -
 - a. List of software, copies of installation and user manuals
 - b. Sequences of operation
 - c. Flow charts of implementation of operating sequences
 - d. Data files of point function programming, entered set points and parameters, etc. This is to be a permanent file, available for update throughout the life of the control system.
- F. Upon completion of the work, provide a complete set of 'as-built' drawings and application/backups software on compact disk and a digital delivered package to SPD engineers. Drawings shall be provided as AutoCAD™ or Visio™ compatible files and include a complete PDF bookmarked set. Contractors shall provide as-builts for their portions of work. The Division 23 contractor shall be responsible for as-builts pertaining to overall BMS architecture and network diagrams. All as-built drawings shall also be installed into the BMS server in a dedicated directory and accessible through a menu option in the Graphical User Interface (GUI). Include IP address and software addresses for equipment connected to the BMS.

1.4 SPECIFIC NOMENCLATURE

- A. Acronyms used in this specification are as follows:
 - 1. BMS - Building Management System
 - 2. JACE – Java Application Control Engine
 - 3. GUI - Graphical User Interface



4. DDC - Direct Digital Controls
5. LAN - Local Area Network
6. WAN - Wide Area Network
7. PICS - Product Interoperability Compliance Statement
8. HTML - Hypertext Markup Language
9. XML - Extensible Markup Language
10. NCP - NetWare Core Protocol
11. ATMD - Active Tuned Mass Damper
12. SSL – Secure Socket Layer
13. TSL – Transport Layer Security
14. BTL - BACnet Testing Laboratory

1.5 DIVISION OF WORK

- A. The Division 23 Contractor shall be responsible for all controllers (Field Controllers), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.
- B. The Division 23 contractor shall be responsible for the JACE(s) BMS, software and programming of the BMS, GUI software, development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, and connection of the BMS to the local or wide area network.

1.6 RELATED REQUIREMENTS

- A. Division 26, Electrical:
 1. Providing motor starters and disconnect switches.
 2. Power wiring and conduit.
- B. Provision, installation and wiring of duct smoke detectors.
 1. Other equipment and wiring as specified in Division 26.
- C. Division 23 - See mechanical work and equipment required for installation of BMS including but not limited to -
 1. Piping of control valves
 2. Water flow switches
 3. Water pressure and differential pressure taps.
 4. Thermal wells in piping.
 5. Dampers in ducts and at air handling units.
 6. Openings and holes in duct, plenum, and air handling units for pressure sensors and temperature sensors.
 7. Division 23 - This section furnishes control valves as scheduled.

1.7 AGENCY AND CODE APPROVALS

- A. Products of the BMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
 1. UL-916; Energy Management Systems
 2. FCC, Part 15, Subpart J, Class A Computing Devices

1.8 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 BMS, BMS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs passwords, passphrases for access to any component or software program shall be provided to the owner.
- C. The installer shall provide NiCS statement to the owner before equipment is approved. The Niagara Software shall allow open access and be set as follows: accept.station.in="*" accept.station.out="*" accept.wb.in="*". The contractor shall not install any software, applications or utilities that are limited in functionality based on the brand of Niagara Framework based device.
- D. Licensing, maintenance and programming tool shall be included as part of the one-time controller cost. Provide a written agreement that no periodic or recurring software costs will be applied as they are not accepted by the owner when establishing the contract.
- E. Software tools necessary to program, configure, download and service the entire BMS system shall be provided and meet all terms of section 1.01.E.3

1.9 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 equipment damage. Store equipment and materials inside and protected from weather.

1.10 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.
- B. Temple Recommends – Once the building is dedicated only Temple Recommend holders will be allowed access the building.

1.11 SCHEDULING

- A. Coordination
 - 1. Coordinate planning and installation of equipment with parties specified to be involved in BMS including but not limited to -
 - a. Representative from Control Subcontractor.
 - b. Mechanical Subcontractor
 - c. Owner Engineers
- B. CLOSEOUT
Manuals –
 - 1. Submit the following manuals for use in operator training and ongoing reference for facility operators – Provide one digital copy in pdf format for each. Bookmark each topic in the pdf.
 - a. Operator's Manual
 - b. Third Party Software Manuals



- c. O & M manuals including revised As Built documents of materials listed under Shop Drawings and copies of warranties. Include complete wiring and piping interconnection diagrams showing panel and device power and sources.

PART 2 – MATERIALS

2.1 GENERAL

- A. The BMS shall be comprised of a network of interoperable, stand-alone digital controllers, graphical user interface software, 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 BMS.

2.2 OPEN, INTEROPERABLE, INTERGRATED ARCHITECTURES

- A. The intent of this specification is to provide a networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, technology, MODBUS, OPC, and other open communication protocols in one open, interoperable system.
- B. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs.

2.3 NETWORKS

- A. The Local Area Network (LAN) is Ethernet based. Most industry protocols like BACnet, Java, XML, HTTPS, and HTMLxx are supported. Owner provides and configures the network equipment for the building network switches and routers. The contractor may temporarily install and use other network switches for testing purpose until the owner install the building network equipment. Installation and testing schedule are coordinated by the owner Project Manager.
- B. Transmission Control Protocol (TCP) is configured by the owner for full-duplex, bidirectional traffic. TCP ports open by default are ports 80, 443, 1911, 3011, 4911, and 5011. Installation schedule or exceptions request are coordinated by the owner Project Manager.

2.4 NETWORK ACCESS

- A. On site access to the JACEs and the supervisor computer can be achieved by connecting to any network ports configured on a building network switch using TCP IP protocol. The computer used when connecting to the LAN must have a proper OS license and an up-to-date properly licensed anti-virus.
- B. Remote access to the JACEs and the supervisor computer is done via the Internet using TCP IP protocol. It requires a secure and unique credential (username and password) and owner approved remote access software.
- C. Computer installed browser: it gives remote access the web interface of either the JACEs or the supervisor computer.

2.5 JACE

- A. The contractor shall supply one or more JACEs Niagara 4 as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided. Provide



Niagara controllers with add on I/O modules to provide auxiliary monitoring and control functions. Provide open Niagara 4 controllers.

- B. The JACE shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.
- C. Event Alarm Notification and actions
 - 1. The JACE shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - 2. The JACE shall be able to route any alarm condition to any defined user location whether connected to a local network or wide-area network.
 - 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - a. To alarm
 - b. Return to normal
 - c. To fault
 - 4. Provide timed (schedule) routing of alarms by class, object, group, or node.
 - 5. 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.
- D. Control equipment and network failures shall be treated as alarms andannunciated.
- E. The following shall be recorded by the JACE 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.
- F. The Niagara supervisor shall provide the interface between the LAN or WAN and the Jaces and provide global supervisory control functions over the control devices. 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
- G. Event Alarm Notification and actions
 - 1. The Niagara Supervisor shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - 2. The Niagara Supervisor shall be able to route any alarm condition to any defined user location whether connected to a local network, or wide-area network.
 - 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - a. To alarm
 - b. Return to normal
 - c. To fault
- H. Alarm actions may be initiated by user defined programmable objects created for that purpose.
- I. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- J. A log of all alarms shall be maintained by the Niagara Supervisor and shall be available for review by the user.

- K. Provide a “query” feature to allow review of specific alarms by user defined parameters.
- L. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- M. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.6 DATA COLLECTION AND STORAGE

- A. The Niagara Supervisor 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 Niagara Supervisor that shall have, at a minimum, the following configurable properties: Designating the log as interval, change of value (COV) absolute or COV above a tolerance.
 - 1. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - 2. For COV logs, the object shall be configured for any change of value or a deviation above a certain value. This value, when reached, will initiate logging of the object.
 - 3. 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.
 - 4. Each Niagara Supervisor log shall maintain 15 months history. Each JACE shall maintain 3-5 days history. All systems shall have the ability to have its data cleared on a time-based event or by a user- defined event or action.
- C. All log data shall be stored in the Niagara Supervisor and the data shall be accessed through a standard Web browser.
- D. All log data shall be available to the user in the following data formats:
 - 1. HTML
 - 2. XML
 - 3. Plain Text
 - 4. Comma or tab separated values
- E. The Niagara Supervisor shall have the ability to archive its log data.
 - 1. Archive on time of day
 - 2. Archive on user-defined number of data stores in the log (buffer size)
 - 3. Archive when log has reached its user-defined capacity of data stores
 - 4. Provide ability to clear logs once archived

2.7 AUDIT LOG

- A. Provide and maintain an Audit Log that tracks all activities performed on the BMS. 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 BMS), to another BMS 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.

2.8 DATABASE BACKUP AND STORAGE

- A. The BMS shall have the ability to automatically backup its database. The database shall be



backed up based on a user-defined time interval.

- B. Copies of the current database and, at the most recently saved database shall be stored in the Niagara Supervisor. The age of the most recently saved database is dependent on the user-defined database save interval.

2.9 FIELD CONTROLLER

- A. HVAC control shall be accomplished using BACnet based devices that are either fully programmable or application specific to satisfy the defined sequence of operations.
- B. The Division 25 contractor shall provide all programming and documentation.
- C. The Division 25 contractor shall run the BACnet network trunk to the nearest JACE. Coordinate locations of the JACE to ensure that maximum network wiring distances, as specified by the BACnet wiring guidelines, are not exceeded. A maximum of 64 devices may occupy any one BACnet trunk and must be installed using the appropriate trunk termination device.
- D. The JACE will provide all scheduling, alarming, trending, and network management for the BACnet based devices.
- E. The Field Controllers shall communicate with the JACE at a baud rate of 78.8 and not less than 38.4K baud. The BACnet shall provide LED indication of communication and controller performance to the technician, without cover removal.
- F. Control sequences within or programmed into the Field Controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
- G. The Division 23 contractor supplying the Field Controllers shall provide documentation for each device.
- H. It is the responsibility of the Division 23 contractor to ensure that the proper Network Variable Inputs and Outputs (nvi and nvo) are provided in each IDC, as required by the point charts.
- I. All physical points shall terminate on the same IO ports consistently by application throughout the building

2.10 GRAPHICAL USER INTERFACE SOFTWARE (GUI)

- A. Operating System:
 - 1. The GUI shall be provided and developed on the owner provided server.
- B. The GUI shall provide standard browser access for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
- C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
 - 1. Graphic screens backgrounds shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the

- GUI shall support the use of scanned pictures.
2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
 3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
 4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 5. Commands to start and stop binary objects shall be done by Selecting selected object and selecting the appropriate command from the pop-up menu.
 6. Adjustments to analog objects, such as set points, shall be done by Selecting the selected object and adjusting the value.
 7. Graphics shall be based on the standard Niagara 4 Tridium images. Custom copyrighted graphics are not acceptable.
- D. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen.
- E. System Diagnostics. The system shall automatically monitor the operation of all workstations, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the alarm console.
- F. Alarm Console
1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.11 SYSTEM PROGRAMMING

- A. Programmer shall use the latest version of the Niagara 4 programming tool.

2.12 OTHER CONTROL SYSTEM HARDWARE

- A. Space Temperature Wall Module.
1. Space temperature sensors shall be thermistor sensor and accurate to plus or minus one F degree.
 2. Where specified, space temperature sensors shall have a setpoint knob calibrated for warmer-cooler adjustments (option: calibrated to allow plus or minus adjustments to a software setpoint) and/or override capability.
- B. Control Valves: (Characterized Ball Valves). All control valves up to 2" shall be characterized ball valves. Control valves ½ to 2 inches shall be 2-way or 3-way forged brass screwed pattern as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.



1. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings).
 2. Two-way water valves shall have equal percentage flow characteristics and three-way valves shall have equal percentage flow characteristics straight through and linear flow through the bypass.
 3. Leakage rate shall be ANSI Class IV (no more than 0.01% of Cv).
 4. Valves shall be rated for no less than 350 psig at no less than 250 degrees F.
 5. Provide a removable handle to operate valves manually during actuator power loss or failure.
 6. Two-way valves shall close off against 100 psi minimum, and three-way valves shall close off against 40 psi minimum.
 7. Valves shall have stainless-steel or chemically nickel-plated brass stem and throttling port.
 8. Valves shall be tagged with Cv rating and model number.
- C. Butterfly Control Valves: Where specified butterfly control valves over 2" in size shall be cast iron body type for 2-way or 3-way applications specified constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.
1. Valves shall have tapped lugs for standard flange connection and designed for isolation and removal of downstream piping at full rated pressure.
 2. Two-position valves shall be 'line' size.
 3. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings).
 4. Valves shall be rated for bubble tight shutoff at no less than 150 psi.
 5. Valve disc shall be aluminum bronze.
 6. Valve stems shall be stainless steel, with inboard top and bottom bronze bearings, and an external corrosion resistant top bearing to absorb actuator side thrust.
- D. Duct Mount, Pipe Mount and Outside Air Temperature Sensors: Temperature sensors with an accuracy of + 0.3° F. Temperature sensors shall be Honeywell.
1. Outside air sensors shall include an integral sun shield.
 2. Duct sensors shall have sensor approximately in center of the duct, and shall have selectable lengths of 6, 12, and 18 inches.
 3. 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).
 4. Pipe mount sensors shall have copper, or stainless-steel separable wells.
- E. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point shall be provided where specified. Current switches shall include an integral LED for indication of trip condition and a current level below trip set point. Provide VFD rated where used with VFD.
- F. 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. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag.
 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.
- G. Low Temperature Limit Switches. Limit switches shall be Honeywell. Safety low limit dual contact shall be manual reset twenty-foot limited fill type responsive to the coolest section

of its length.

- H. High Temperature Limit Switches. Limit and Safety switches shall be Honeywell. Safety high limit (firestats) shall be manual reset type.
- I. CO2 Sensors. CO2 sensors shall be Honeywell.
 - 1. Carbon Dioxide sensors shall be 0-10 Vdc analog output type, with corrosion free gold-plated non-dispersive infrared sensing, designed for duct mounting.
 - 2. Sensor shall incorporate internal diagnostics for power, sensor, analog and output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-2000 PPM with +/- 50 PPM accuracy.
- J. Humidity Sensors. Humidity sensors shall be Honeywell.
 - 1. Duct and room sensors shall have a sensing range of 5% to 95%.
 - 2. Duct sensors shall be provided with a sampling chamber.
 - 3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH. They shall have a compensated ambient temperature range of -40°F to 170° F.
- K. Enthalpy Sensors. Enthalpy sensors shall be Honeywell. Duct mounted enthalpy sensor shall include a temperature sensor and a humidity sensor constructed to close an electrical contact upon a drop-in enthalpy (total heat) to enable economizer modes of operation where specified.
 - 1. Where specified provide duct mounted sensor including solid state temperature and humidity sensors with electronics which shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.
- L. Annular Pitot Tube Flow Meter. Annular pitot tube shall be averaging type differential pressure sensors with four total head pressure ports and one static port made of austenitic stainless steel.
 - 1. Sensor shall have an accuracy of $\pm .25\%$ of full flow and a repeatability of $\pm .05\%$ of measured value.
 - 2. Transmitter shall be electronic and shall produce a linear output of 4 to 20 mAdc corresponding to the required flow span.
 - 3. The transmitter shall include noninteracting zero and span adjustments.
- M. 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. All electrical devices within a control panel shall be factory wired. All external wiring shall be connected to terminal strips mounted within the panel. 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.
- N. Field devices and components shall be as scheduled on the drawings or required Contract Documents and have a UL/ETL 508 listing.
 - 1. Analog Input Sensors: Should provide other manufacture numbers
 - a. TR Series - Space Temperature Sensor with Set point.
 - b. C7 Series - Duct Temperature Sensor.
 - c. C7 Series - Mixed Air Averaging Temperature Sensor 144".
 - d. C7 Series - Water Temperature Sensor (must order well separately)
 - e. 50001774-001 - Water Temperature Sensor Well
 - f. H7635B1004 - Duct Humidity/Temperature Sensor & Cover (mA)
 - g. C7232B1014 - Return Air CO2 Sensor 4-20Ma
 - h. C7 Series - OA Temperature Sensor.

- i. P7640A Building Static Pressure Transducer 4-20mA (or equivalent)
 - j. P7640B Duct Static Pressure Transducer 4-20mA (or equivalent)
 - k. MMCP274-R3-mA - Duct static transducers (mA) (or equivalent)
 - l. MMCP274-R2-mA - Building space static/return air static sensor (or equivalent)
 - m. H7635C1002 - System outside air humidity/temp sensor (mA)
 - n. PhotoCell (Analog Input)
 - o. MMCP264-R1-mA - Water differential pressure sensor (or equivalent)
 - p. MMCP264-R2-mA - Water differential pressure sensor (or equivalent)
 - q. MMCP264-mA - Water differential pressure sensor to measure water flow (or equivalent)
 - r. MMCP264-R1-mA - Water pressure sensor
2. Digital Input Sensors: (Provide Honeywell.)
- a. TDIAP521030 - Duct High/Low Limit Pressure Safety Switch (or equivalent)
 - b. Adjustable, MCSP-A .7-250A - Run Status
 - c. Adjustable, CSP-O-F10-001 1.5-250A - Run Status.
 - d. Adjustable Functional Devices, Inc. R1BXGTF.35-150A - Run Status.
 - e. Adjustable Functional Devices, Inc. R1BXGTA.75-150A - Run Status.
 - f. RIBU1C - Field Relay for Bypass Input
 - g. DH100ACDCLP - Duct smoke detector
 - h. ST-3 - Duct smoke detector sampling tube
 - i. L482A - Low Limit (or equivalent)
 - j. RIBU1C - Remote Field Mounted Relay
 - k. RH2B-UL-24VAC - Idec 24VAC Relay
 - l. SH2B-05 - Relay Socket
 - m. BND1000 - Din Rail
 - n. MS8120A1007 - 2 Position Spring Return Damper Actuator 175 in-lb. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each damper controlled.) Provide damper actuator of equal or greater quality.
 - o. MN6120A1002 - 2 Position Non-Spring Return Damper Actuator 175 in-lb. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each damper controlled.) Provide damper actuator of equal or greater quality.
 - p. RIB2401D - Remote field mounted relay (DPDT)
3. Analog Output Devices: (Provide Honeywell.)
- a. MS7520A2007 - Modulating Damper Motor - Spring Return (16VA) - 175 in-lb. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality.
 - b. MN7220A2007 - Modulating Damper Motor - Non Spring Return (6VA) - 175 in-lb. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality.
 - c. VGF21LSxx - 2-Way globe valve. Size valve according to valve schedule.
 - d. 3-Way globe valve. Provide Honeywell. Size valve according to valve schedule.
 - e. ML7421A1032 - Globe valve actuator - non-spring return (12VA) or equivalent. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality.
 - f. VB2-XX-CV-SD - 2-Way ball valve w/MS7505A2008 actuator (13 VA) or equivalent. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality.

- g. VB3-XX-CV-SD - 3-Way ball valve w/MS7505A2008 actuator (13VA).
- h. Spyder (should provide additional controller names) or Equivalent - CFCU fan coil controller
- i. C7 Series - Duct temperature sensor with 6" probe.
- j. TR Series - Space Temperature Sensor with Set point
- k. TR100VA002 - 100VA Transformer
- l. VB2xySA & VB3xySA - VAV box reheat valve (ball valve w/ML6161B2024) or equivalent. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality. Honeywell 3-way ball valves do not have stainless steel trims.
- m. 24VAC/100 VA transformer panel housing

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 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. Acceptable Installers:
 - 1. Harris Mtn West – (208)681-9130
 - 2. Or Approved Equal
- C. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.
- D. Drawings of the BMS and BMS 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.
- E. 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.
- F. 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.
- G. Shop fabricate and assemble all control Panels. Mount and wire BMS field devices for DDC systems. Make a complete installation. Such devices include, but are not limited to:
 - 1. Direct Digital Control (DDC) of air and water temperature, static and differential pressure sensing and control, damper and valve actuation, variable volume box control, electric relays, switches, transformers, and any and all other devices needed to make a complete system
 - 2. Furnish and install wire, conductors, cables, control devices, panels, conduit etc. required for complete installation of BMS devices. Make terminations. Check all installation for wiring and termination integrity.
 - 3. Provide control system related materials and installation related to HVAC controls.
 - a. Provide new controls for all air handlers, exhaust fans, and HVAC mechanical systems related equipment.

3.2 WIRING

- A. All electrical control wiring and low voltage wiring to the control panels, BMS, computers



and network components shall be the responsibility of this contractor.

- B. The electrical contractor (Div. 26) shall furnish all power wiring to electrical starters, motors & control panels.
- C. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. BMS wiring shall be installed in the as specified in the Project Electrical Specifications (Division 26,27). Do not combine with other systems cabling.

3.3 WARRANTY

- A. Equipment, materials, programming 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 BMS during the warranty period.
- B. The owner shall allow the contractor to access the BMS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 SOFTWARE LICENSE

- A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.
- B. The owner, or his appointed agent, shall receive ownership of all job specific software 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 within the BMS. Any and all required ID's and passwords for access to any component or software program shall be provided to the owner.

3.6 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 debugging and perform all required operational checks to ensure 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. System Acceptance: Satisfactory completion is when this contractor and the Division 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.

3.7 DAA CONTROL AND GRAPHIC SUMMARY



A. General:

1. List of hardware points for each DDC controller appears on Mechanical Drawings. Graphics showing these points, along with appropriate pseudo points (i.e. set points, etc.) shall be incorporated into operational graphics.
 - a. Provide software graphics and programming required to accomplish detailed sequence of operations.

3.8 SEQUENCES OF OPERATION

A. General

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

B. Distributed Control

1. System shall observe the concept of distributed control. Modules shall be located at each operating equipment location such that individual systems or zones shall remain functional without communication to other systems on the network.

C. Central Plan, Pump and Fan Operation

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

D. Operation

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

END OF SECTION 23 0953

SECTION 23 2113 - HYDRONIC PIPING**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride.
- B. PVC: Polyvinyl chloride.

1.4 SUBMITTALS

- A. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
- B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- E. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 23.
- F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

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



1.6 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.
- F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

1.7 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grooved Mechanical-Joint Fittings and Couplings:
 - a. Central Sprinkler Company; Central Grooved Piping Products.
 - b. Grinnell Mechanical Products.
 - c. Victaulic Company of America.
 - 2. Calibrated Balancing Valves:
 - a. Armstrong Pumps, Inc.
 - b. Flow Design, Inc.
 - c. Gerand Engineering Company.
 - d. Griswold Controls.
 - e. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - f. Taco, Inc.
 - 3. Pressure-Reducing Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - e. Spence Engineering Company, Inc.
 - f. Watts Industries, Inc.; Watts Regulators.
 - 4. Safety Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.



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

2.2 PIPING MATERIALS

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

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.
- F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 through NPS 12: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.
- C. Steel Pipe, NPS 14 through NPS 18: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 30, black steel, plain ends.
- D. Steel Pipe, NPS 20: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 20, black steel, plain ends.
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.
- E. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.



- F. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- G. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- H. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
- I. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- J. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- K. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
- L. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- M. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.
- N. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.
- O. Packed, Slip, Expansion Joints: 150-psig minimum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, packing ring, packing, limit rods, flanged ends, and chrome-plated finish on slip-pipe telescoping section.
- P. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- Q. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441, Schedules 40 and 80, plain ends.
- B. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends.
- C. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
 - 1. CPVC Solvent Cement: ASTM F 493.
- D. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe;



ASTM D 2467 for Schedule 80 pipe.

1. PVC Solvent Cement: ASTM D 2564.

2.6 VALVES

- A. Gate, globe, check, ball, and butterfly valves are specified in Division 23 Section "Valves."
- B. Refer to Part 3 "Valve Applications" Article for applications of each valve.
- C. Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
- D. Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
- E. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.
- F. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.
- G. Automatic Flow-Control Valves: Gray-iron body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Valve shall be line size and one of the following designs:
 1. Gray-iron or brass body, designed for 175 psig at 200 deg F with stainless-steel piston and spring.
 2. Brass or ferrous-metal body, designed for 300 psig at 250 deg F with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
 3. Combination assemblies, including bronze ball valve and brass alloy control valve, with stainless-steel piston and spring, fitted with pressure and temperature test valves, and designed for 300 psig at 250 deg F.
- H. Plastic Ball Valves: 150-psig working pressure, 250 deg F maximum operating temperature, full port design, 1- or 2-piece body design, CPVC body and ball, polytetrafluoroethylene seats, EPDM seals, and tee handle; with threaded, socket, union, or flanged connections.
- I. Plastic Butterfly Valves: 150-psig working pressure, 250 deg F maximum operating temperature, PVC wafer body, polytetrafluoroethylene seats, lever lock handle, and wafer style for installation between flanges.

2.7 HYDRONIC SPECIALTIES

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



- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.
- C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Include the following fittings and accessories:
1. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Design tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
 2. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; designed to admit air to compression tank, drain water, and close off system.
 3. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.
- D. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a flexible bladder securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- E. Tangential-Type Air Separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.
- F. In-Line Air Separators: One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 175 psig and liquid temperature up to 300 deg F.
- G. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig and temperature of 250 deg F.
- H. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- I. Diverting Fittings: 125-psig working pressure; 250 deg F maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.
- J. Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.

- K. Basket Strainers: 125-psig working pressure; high-tensile cast-iron body (ASTM A 126, Class B), flanged-end connections, bolted cover, perforated stainless-steel basket, and bottom drain connection.
- L. T-Pattern Strainers: 750-psig working pressure; ductile-iron or malleable-iron body, grooved-end connections, stainless-steel basket with 57 percent free area; removable access coupling and end cap for strainer maintenance.
- M. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.
- N. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.
- O. Packed, Slip, Expansion Joints: 150-psig minimum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, packing ring, packing, limit rods, flanged ends, and chrome-plated finish on slip-pipe telescoping section.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Heat Pump Water, NPS 2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints. Belowground or within slabs, use Type K annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs.
- B. Heat Pump Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded and flanged joints.
- C. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints or Schedule 40, PVC pipe with solvent-welded joints.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Gate, ball, and butterfly valves.
 - 2. Throttling Duty: Globe, ball, and butterfly valves.
- B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- C. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for

installation requirements.

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

3.3 PIPING INSTALLATIONS

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- G. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- H. Anchor piping for proper direction of expansion and contraction.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.
- B. Install the following pipe attachments:
 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer. cal runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

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

3.6 HYDRONIC SPECIALTIES INSTALLATION

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



- C. Install dip-tube fittings in boiler outlet. Install piping to expansion tank with a 2 percent upward slope toward tank. Connect boiler-outlet piping.
- D. Install in-line air separators in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install drain valve on units NPS 2 and larger.
- E. Install combination air separator and strainer in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install blowdown piping with gate valve; extend to nearest drain.
- F. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
- G. Install expansion tanks above air separator. Install gage glass and cocks on end of tank. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, and fittings, plus weight of a full tank of water. Do not overload building components and structural members.
- H. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If multiple, parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure and temperature gages at coil inlet connections.

3.8 CHEMICAL TREATMENT

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

3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
 3. Check expansion tanks to determine that they are not air bound and that system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.

3.10 ADJUSTING

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

3.11 CLEANING

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

END OF SECTION 23 2113

SECTION 23 2118 – BACKFLOW PREVENTER VALVE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION 23 2118

SECTION 23 2123 – CIRCULATING PUMPS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

PART 2 - PRODUCTS

2.1 BASE MOUNTED PUMPS

- A. Packless flexible coupled, end suction vertically split case design to facilitate servicing all internal components without disturbing pump, volute or motor. The pump volute shall be supplied with plugged vent, drain, and gage tappings. The pump casing shall be of Class 30 cast iron, suitable for 175 PSI working pressure.
- B. The pump and motor shall be mounted on a common base plate of heavy structural steel design and securely welded cross members and open grouting area. Securely bolted to isolation base as specified and to the 6-inch high concrete base. Weight of piping shall not be supported on pumps. The pump shall be factory tested before shipment.
- C. The motor shall meet NEMA specifications and shall be the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the Contractor after installation prior to start up.
- D. 1750 rpm with bronze impeller, wearing rings, stainless steel shaft, and ceramic seal. The pump bearings shall be the regreasable camlock ball bearing type with provision for purging or flushing through the bearing surface, and capable of being inspected by removing the bearing cover. The shaft shall be of 18-8 stainless steel on standard mechanical seal models.
- E. Internally-flushed seals shall be mechanical type with ceramic seal and carbon ring, suitable for continuous operation at 225 deg. F. The seals shall be capable of being serviced without disconnecting the pump from piping.
- F. Impeller shall be of the enclosed end-suction type in bronze construction and shall be dynamically balanced for quiet operation. Impeller shall be shaved to provide exact operating point specified on drawings. Motor size shall be as shown on drawing but if an alternate pump is supplied that could operate in the overload range, a large motor shall be furnished. Motor shall not operate overloaded. Any additional electrical cost for oversized motor shall be borne by pump manufacturer's representative.
- G. A flexible, Center Drop-out spacer type coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Coupler shall be shielded by a Coupler Guard securely fastened to the base.
- H. Approved Manufacturers:
 - 1. Bell & Gossett

2. Armstrong
3. Grundfos

2.2 SUSPENDED WET PIT PUMPS

- A. The pump casing shall have an integrally cast discharge flange. The suction strainer shall be fabricated 304 stainless steel with iron bottom plate.
- B. The impeller shall be semi-open and capable of passing 1 3/8" solids. The impeller shall contain a balancing ring and be cast in iron and be secured to shaft by taper fit, with Woodruff key, castellated nut, washer and cotter pin.
- C. All shafting shall be 316 stainless steel and shall be a minimum of 1 1/4" diameter between the coupling and the impeller. Column pipe shall be steel with welded flanges machined for registered fit.
- D. The pump bearing, located directly above impeller, shall be of bronze. Bearing housing shall be of 316 stainless steel.
- E. An intermediate bearing of the same materials as the pump bearing must be provided on pumps in excess of 6'-0" in length. On intermediate bearing for each additional 5'-0" pump length shall be furnished.
- F. Pump and intermediate bearings shall be water lubricated through separate lubrication lines terminating at the cover plate.
- G. The motor support shall be of cast iron, machined to assure positive alignment of motor and pump shaft, fitted with a high thrust angular contact bearing with moisture-proof enclosure and grease seals. External impeller and shaft axial adjustment shall be provided.
- H. Water make-up operation shall be controlled by a float operated switch. Float rod shall be fiberglass. Float shall be 304 stainless steel. Float stops shall be 304 stainless steel.
- I. The flexible coupling between the motor and pump shafts shall be Woods Sure-Flex spacer type coupling.
- J. Pumps shall be driven by a standard "C" face vertical electric motor.

2.3 PUMP SUCTION DIFFUSERS:

- A. Match system pipe size and pump inlet size shall be furnished and installed where shown on drawings.
- B. Angle type body with inlet vanes and combination diffuser-strainer-orifice cylinder.
- C. Approved Manufacturers:
 1. Bell & Gossett
 2. Armstrong
 3. Or approved equal

2.4 TRIPLE DUTY VALVES

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



- B. Cast iron body
- C. Bronze disk and seat with stainless steel stems and springs.
- D. Teflon packing
- E. Maximum valve working pressure of 175 psig and a maximum operating temperature of 300 deg. F.
- F. Approved Manufacturers:
 - 1. Bell & Gossett
 - 2. Armstrong

2.5 EXPANSION JOINT PUMP CONNECTORS

- A. Precision machine molded neoprene and nylon construction internal reinforced by means of steel wire.
- B. Cadmium steel floating flanges tapped to mate with 150# ASA companion flanges.
- C. Capable of operating at a temperature of 20 deg. F. thru 220 deg. F. and at a pressure ranging from 10" HG vacuum thru 150 psi working pressure.
- D. Capable of 15 deg. angular deflection.
- E. Twin quiet-sphere design with control rods.
- F. Approved Manufacturers:
 - 1. Vibration Mountings & Controls, Inc.
 - 2. Metraflex

2.6 IN-LINE CIRCULATORS

- A. Bronze fitted with ceramic seal, spring coupling, and 1750-rpm, drip-proof motor with overload protection.
- B. Substantially supported in piping with a full size leg to floor.
- C. Approved Manufacturers:
 - 1. Bell & Gossett
 - 2. Armstrong
 - 3. Grundfos

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment in accordance with manufacturers instructions.
- B. Align pump and motor shafts in accordance with manufacturers requirements before starting equipment. Provide report in the M&O manual regarding pump alignment.
- C. Remove start-up filter screen on suction diffuser after system has been cleaned and flushed. Leave main filter screen in place.

END OF SECTION 23 2123



SECTION 23 2125 - CLEANING AND FLUSHING WATER CIRCULATING SYSTEMS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Furnish labor and materials to thoroughly clean water circulating systems as described in Contract Documents.
- B. Mechanical contractor shall procure the services of an independent treatment contractor as described in this specification.

1.3 QUALITY ASSURANCE

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

PART 2 - EXECUTION**2.1 FIELD QUALITY ASSURANCE**

- A. Water circulating systems for project shall be thoroughly cleaned before placing in operation to rid system of dirt, piping compound, mill scale, oil, and other materials foreign to water being circulated.
- B. During construction extreme care shall be exercised to prevent dirt and other foreign matter from entering pipe or other parts of system. Pipe stored on project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fittings, or valve shall be visually examined and dirt removed.
- C. Side Stream Filtration and Flushing Valves
 1. The Mechanical Contractor shall install a bag style side stream filter in the main mechanical room. This filter shall be furnished with 12 clean polyester bags with a filtration rating of 5 micron. The filter shall be sized to provide a pressure drop equal to the pressure drop of the parallel component with 80% flow through the primary component and 20% through the filter. Minimum filter size shall be 18" high and 6" in diameter. If this minimum size allows excessive flow through the side stream filter a balance valve shall be installed to insure sufficient flow through the primary central plant component.
 2. Ball valves of full line size shall be installed at the end of each primary run. The valves shall have a nipple and cap installed.
- D. Hydronic Heat Pump Closed Loop Cleaning
 1. Prior to any introduction of fluids to the closed loop system the Mechanical Contractor shall close isolation valves at each heat pump and open the bypass valve to prevent flow through the strainer, flow control device and heat pump during the initial flushing and subsequent cleaning. The side stream filter bag shall be removed during the initial flushing process.
 2. The Mechanical Contractor shall fill each hydronic system with clean fresh water prior to cleaning and thoroughly leak check system piping. A cleaning and passivating agent

- supplied by the Chemical Treatment Contractor shall be added to the system at the direction of the Treatment Contractor during the leak check process to minimize initial corrosion. If the system is filled multiple times during the leak check and repair process the Mechanical Contractor shall coordinate with the Treatment Contractor to maintain this initial protection. The Treatment Contractor is responsible for providing chemical for up to two refills of the system. If additional chemical is required due to multiple refillings the Mechanical Contractor shall be responsible for the additional time and chemical.
3. Following leak check the closed system shall be flushed by the Mechanical Contractor until the leaving water runs clear. All primary runs shall be flushed at their ends to obtain maximum sweep of debris from the system. The inlet screens on the circulating pumps must be kept clear during this initial cleaning process and inspected following cleaning. When flushing is complete the system is to be left full.
 4. Prior to flushing the Mechanical Contractor shall coordinate with Treatment Contractor so that the Treatment Contractor can be available immediately following flush and final refill to add cleaning chemical within 4 hours to prevent initial corrosion.
 5. Following initial flushing the Chemical Treatment Contractor shall refill all systems with cleaning and passivating agents raising the PH to a minimum of 10, circulate and flush until thoroughly clean. All primary piping runs shall be flushed at the ends during this cleaning process. When boiler operation is available the loop temperature should be raised to 110 to 120° to accelerate cleaning. Cleaning with availability of boiler operation should be anticipated to last 7 to 10 days or longer depending on initial loop conditions. If boiler operation is unavailable loop cleaning duration should be expected to double. The Chemical Treatment Contractor shall verify and adjust cleaning chemistry, and inspect side stream filter bags at a minimum of every two days, exception for weekends. Filter bags shall be changed as required during this cleaning process. Cleaning shall continue until these bags no longer show signs of debris.
 6. Following cleaning process the Treatment Contractor shall close the bypass valves at each heat pump and open isolation valves for normal operation and check for leaks of local piping connections. Any leaks found shall be referred to the Mechanical Contractor for repair. The bypass valve handle shall be removed and tied to the valve. The system shall then be charged with final operating chemical to control long term corrosion and a clean bag filter shall be installed in the system.
 7. The Treatment Contractor shall provide final inspection report for inclusion in the Operation and Maintenance Manual. Additionally the Treatment Contractor shall take loop samples approximately 12 months following completion, add or adjust chemical as required and provide a post construction report to the owner prior to warranty closeout. Chemical required is the responsibility of the Treatment Contractor.
- E. Fluid Cooler Chemical Treatment Station
1. A chemical treatment station shall be provided by the Treatment Contractor in a 24" x 24" locked cabinet. Station shall include LMI DC4000-1-1 conductivity meter with sensor and A-17-1-1351S chemical pump, or approved equal. The chemical station shall be located inside the mechanical room. Mechanical Contractor shall provide ¾" PVC piping from the discharge of the spray pump of the fluid cooler to the station enclosure with T's for installation of the conductivity sensor and for chemical injection. This contractor shall also provide return piping back to the fluid cooler sump at the opposite end from the spray pump pickup. The Treatment Contractor shall install the conductivity sensor and injection fitting in the T's provided and set up initial treatment.
 2. Under the scope of this specification the Treatment Contractor shall monitor the tower sump and adjust feed and bleed to maintain proper control of scale and corrosion for a period of one year. At a minimum tower treatment shall be check monthly from May until October. The Treatment Contractor shall provide all chemical required during the first year of operation

END OF SECTION 23 2125

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 2200 - WATER SOURCE HEAT PUMP SYSTEM**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Furnish and install water source heat pump system as described in Contract Documents.

1.3 QUALITY ASSURANCE

- A. Units of the type furnished shall have been in successful operation at least five years.
- B. Units shall be UL listed and ARI certified, and shall be in accordance with the Canadian Standards Association (CSI).
- C. The units shall have ARI, UL, and CSI labels.
- D. All units shall be factory tested under normal operation conditions and normal water flow rates. Units that are tested without water flow are not acceptable.
- E. Units shall be Climate Master, Trane or Mammoth.

1.4 WARRANTY

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

PART 2 - PRODUCTS**2.1 GENERAL**

- A. System shall consist of water-to-air reverse cycle air conditioning units of the type, size, capacity, and style scheduled on the drawings.
- B. Units shall be interconnected thru a non-refrigerated central water system, maintained within an approximate temperature range of 40 degrees F. to 110 degrees F. by means of a supplementary heat source and closed circuit evaporative type water cooler.
- C. Piping system shall be two-pipe reverse-return as shown on the plans complete with primary and standby circulating pumps.
- D. Individual room temperature control including necessary safety and operating controls shall be furnished as integral or accessory parts of the air conditioning units.

2.2 ELECTRO-HYDRONIC WATER SOURCE HEAT PUMPS

- A. Refrigeration Circuit:
 - 1. Units shall have a sealed refrigerant circuit including:
 - a. A hermetic compressor.
 - b. A refrigerant metering device.
 - c. A finned tube refrigerant to air heat exchanger.



- d. A reversing valve.
 - e. A coaxial (tube in tube) refrigerant to water heat exchanger.
 - f. Safety controls including a high pressure switch, a low pressure sensor, and a low water temperature (thermostat) switch.
2. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service.
 3. Activation of any safety device shall prevent compressor operation via a lock out relay. The lockout relay shall be reset at the thermostat or at the contract furnished disconnect switch. Units which may be reset at the disconnect switch only are not acceptable.
 4. Hermetic compressors shall be internally sprung, externally isolated, with thermal overload protection and shall be located in an insulated compartment to minimize sound transmission. Units above 15,000 BTUH shall have the compressor mounted on spring isolators to reduce noise and vibration transmission. Rubber mounts for these larger units are not acceptable.
 5. Refrigerant to air heat exchangers shall utilize enhanced aluminum fins and rifled copper construction rated to withstand 425 psi refrigerant working pressure.
 6. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 450 psi working refrigerant pressure and 400 psi working water pressure.
 7. Refrigerant metering shall be accomplished by capillary tubes for units intended for use in standard operating ranges, or expansion valves for units intended for use in expanded operating ranges.
 8. Reversing valves shall be four-way solenoid activated refrigerant valves which shall fail to heating operation should the solenoid fail to function.
- B. Fan and Motor Assembly:
1. Units rated 60,000 BTUH and under shall have a direct drive centrifugal fan. The fan motor shall be 3-speed permanently lubricated, PSC type with thermal overload protection. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor shall be isolated from the fan housing by torsionally flexible isolation. Units 72,000 BTUH and above shall have a belt drive fan assembly. The assembly shall include a forward curved fan wheel, housing, solid steel fan shaft encased in ball bearings, fan pulley and adjustable motor sheave. The motor shall be a three phase, open type with external thermal overload protection. The motor shall be mounted on an adjustable base for proper belt tension. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. External static pressure rating of the unit shall be based on a wet coil. Ratings based on dry coil shall not be acceptable.
- C. Electrical:
1. A control box shall be located within the unit and shall contain a transformer, controls for compressor, reversing valve and fan motor operation and shall have a terminal block for low voltage field wiring connections. Open controls in the air stream will not be acceptable. Units shall be name plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 volts and shall provide heating or cooling as required by the wall thermostat. Two compressor units shall have a solid state time delay to prevent both compressors from starting simultaneously. Provide integral interface for DDC control.
- D. Solid State Control System (Optional):
1. Units shall have a solid state control system. The control shall interface with any type of wall thermostat mechanical or electronic. The control system shall have the following features:
 - a. Anti-short cycle time delay on compressor operation, time delay shall be five (5) minutes minimum.

- b. Random start on power up mode or return from night setback.
 - c. Minimized reversing valve operation for extended life and quiet operation.
 - d. Night setback override from low temperature thermostat.
 - e. Two (2) hour override initiated by a signal from wall thermostat.
 - f. Low voltage protection.
 - g. High voltage protection.
 - h. Ability to work with any thermostat.
 - i. Single grounded wire to initiate night setback, demand load shed, or emergency shutdown.
 - j. Unit shutdown on high or low refrigerant pressures.
 - k. Unit shutdown on low water temperature.
 - l. Option to reset unit at thermostat or disconnect.
 - m. Automatic intelligent reset. Unit shall automatically reset the unit 10 minutes after trip if the fault has cleared. Should a fault re-occur within 30 minutes after reset, the permanent lockout will occur.
 - n. Ability to defeat time delays for servicing.
 - o. Light emitting diodes (LED) to indicate high pressure, low pressure, low voltage, high voltage, freeze protection, condensate overflow and control voltage status.
 - p. Control logic shall only move the reversing valve when cooling is called for the first time. The reversing valve shall be held in this position until the first call for heating. This scheme ensures quiet operation and increased valve life. Only control schemes that provide this reduced reversing valve operation will be accepted.
 - q. Control board shall have an eight (8) pin plug to allow the future addition of RS485 DDC circuitry. Control boards that cannot be upgraded to DDC by plugging in a module shall not be allowed.
 - r. Control board shall allow up to three (3) units to be operated from one thermostat without any auxiliary controls.
 - s. Optional 24 volt relay shall be required to provide dry contact alarm when used with a DDC system.
- E. Basic Construction:
- 1. Horizontal units shall be fabricated from heavy gauge (GS90) galvanized sheet metal. All interior surfaces shall be lined with 1/2 inch, 1 1/2 lb. acoustic type glass fiber insulation. All fiberglass shall be coated and have exposed edges tucked under flanges to prevent the introduction of glass fibers into the airstream. All insulation must be NFPA 90A. Vertical unit shall be as above except the cabinet will have a painted baked enamel finish.
 - 2. All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the airstream are not acceptable. Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. Supply and return water connections shall be copper FPT fittings and shall be securely mounted flush to the cabinet allowing for connection to a flexible hose without the use of a back-up wrench. Water connections which protrude through the cabinet or require the use of a backup wrench shall not be allowed.
 - 3. To facilitate installation in minimal space requirements, units rated 30,000 BTUH and under shall have all electrical and water connections on the end of the cabinet opposite the duct connections. Contractor shall be responsible for any extra costs involved in the installation of units which do not have this feature. Contractor must also ensure that non-specified units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.
 - 4. Units shall have the air flow arrangements as shown on plans.
 - 5. Sound attenuation:
 - a. All units 15,000 BTUH and up must have a compressor discharge muffler.
 - b. Compressor side panels and base pan must have closed cell insulation rated at 5 lb/cu. ft. density.

- c. All reciprocating compressors must have high density damping material applied to the compressor shell.
 - d. All units 15,000 BTUH and up shall have the compressors mounted on springs.
- F. Air Filters:
- 1. Units shall have a factory installed two (2) inch thick filter bracket for side filter removal. Units shall have a two (2) inch thick pleated 30% efficient filter. Contractor shall be furnished one (1) set of spare filters to be turned over to Owner on completion of start-up. Filters shall be standard filter sizes. If units utilize non-standard filter sizes, then the contractor shall provide 4 spare sets of filters for each unit.
- G. Units shall be furnished with a condensate overflow switch.
- H. Each individual horizontal or vertical heat pump will have a minimum EER of 10.5 or higher, and a heating COP of 3.8 or higher.
- I. Economizer and Mixing Damper Section:
- 1. Enthalpy O.A. Change-Over Control - measures the total heat content of the air (temperature and humidity).
 - 2. Damper Motor - heavy duty spring return, modulating motor.
 - 3. Economizer Systems - wired to a terminal block complete with transformer, crank arms, swivels and push rods. Available for primary voltages of 208/240, 277 or 480 V.
 - 4. Sequence of Operation - during the cooling cycle the system operates as follows: On a call for cooling by the indoor space thermostat, the damper motor will be energized if the outdoor air conditions are adequate for "free cooling." The outdoor air damper is modulated by the mixed air temperature controller. During economizer operation the mechanical cooling is locked out and the economizer functions as a first stage of cooling.
 - a. The compressor will cycle to maintain space temperature when the outdoor air conditions are not fully adequate. When the outside air is above the changeover set point, the outdoor air damper closes to its minimum position. If the space thermostat is calling for cooling, the compressor will start.
 - b. During the heating cycle the economizer system is automatically locked out, providing maximum fuel economy.
 - c. The economizer closes the outdoor air damper and opens the return air damper when the supply fan is turned off. The economizer accomplishes this when the transformer is wired into the load side of the fan circuit.

2.3 PIPING, PUMPS AND ACCESSORIES

- A. Water piping system shall be installed in accordance with the accompanying drawings to provide a self-balancing two-pipe reverse return arrangement.
- B. Piping shall be graded to prevent air pockets and to enable any entrained air to rise in the direction of flow. Provide air vents where there is a possibility of collecting air.
- C. Provide supply and return connections at each air conditioning unit location shown, plus any possible future locations as shown, to permit expansion or normal relocation and remodeling requirements.
- D. Provide and install two system pumps of capacity and head scheduled on the drawings; one for continuous operation with the other on standby.
- E. Hose Kits:
 - 1. All units 120,000 BTUH and below shall be connected with hoses. The hoses shall be two (2) feet long, metal braided and fire rated to meet UL 94. Non fire rated hoses are

not acceptable. The hose on the supply side of the unit will be complete with a ball valve and strainer. The hose on the return side will be complete with a ball valve and flow control valve that encompasses in one assembly an automatic flow control valve that will guarantee the specified flow rate plus or minus 5% over a wide pressure differential without having any external adjustments. The hose kit and flow control assembly shall be Griswold or Autoflow.

- F. Provide PVC hose or insulated copper condensate connection of each air conditioner to pitched condensate drain system. Connect copper to unit with flexible connection.
- G. Provide water makeup expansion tank, air separator, etc., as shown in Contact Documents.

2.4 CONTROLS

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

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Complete system shall be installed in accordance with manufacturer's approved instructions and shall be equipped with necessary system operating and safety controls as detailed elsewhere in these specifications.
- B. It is ESSENTIAL that the finished piping system be thoroughly flushed free of foreign material and construction debris.
 - 1. Install strainer in system line at pump section.
 - 2. Flush system prior to final connection to any electro-hydraulic conditioner by means of loop bypass between supply to return at each unit location.
 - 3. The hoses for final connection may first be used for the loop bypass.
- C. Provide factory start-up of each heat pump and factory system operation check out of complete system.

END OF SECTION 23 2200

SECTION 23 2500 – CHEMICAL WATER TREATMENT**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Procure services of Water Treatment Service Organization which will:
 - 1. Furnish and install required chemical feeding equipment and perform other related services as described in Contract Documents.
 - 2. Perform initial cleaning and flushing procedures.
 - 3. Provide chemicals required for cleaning and flushing systems.
- B. Related Work Specified Elsewhere:
 - 1. Owner will supply operating chemicals after start-up chemicals have been exhausted.

1.3 SUBMITTALS

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

1.4 MAINTENANCE

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

PART 2 - PRODUCTS**2.1 HOT WATER SYSTEMS**

- A. Two Gallon bypass feeder complete, including piping, valves, and accessories.
 - 1. Provide adequate supply of Dearborn Aqua-Serv B-547 liquid borate-nitrite based corrosion inhibitor.
- B. Approved Manufacturers:
 - 1. M. A. Fleckenstein
 - 2. Neptune
 - 3. Wingert

2.2 COOLING TOWER SYSTEM

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

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Provide initial startup and adjustment of all chemical systems.



- B. Provide instruction to owner in the use and operation of the test kit.
- C. Provide (2) two additional trips to the site during the warrantee period to check and adjust the chemical treatment system.

END OF SECTION 23 2500

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 3318 - SMOKE DETECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

PART 2 - PRODUCTS

2.1 SMOKE DETECTORS

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

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install on systems greater than 2000 CFM and interlock with motor control to shut down fan systems upon smoke detection.
- B. Install as shown on drawings at each smoke/fire damper location and connect to damper. Provide access door as specified in Section 23 3114. Smoke detectors to be installed within 5' of fire/smoke damper.

END OF SECTION 23 3318

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, prefabricated 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. Airlite
 - 2. American Warming
 - 3. Arrow
 - 4. Industrial Louvers
 - 5. Ruskin
 - 6. Vent Products

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 3813 – KITCHEN HOOD**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Furnish and install kitchen hood as described in Contract Documents.
- B. Servicing disconnect, final connection and reconnection of shipping joints is by electrical contractor.

1.3 QUALITY ASSURANCE

- A. Canopy is to be listed by Underwriter's Laboratories, Inc. as "self-contained automatic damper and hood assembly for restaurant cooking appliance."
- B. Canopy is to comply with requirements of NFPA Bulletin #96, NSF and requirements of local authority having jurisdiction.
- C. Fire extinguishing system and canopy is to comply with all applicable sections of NFPA #17 and #96.
- D. Light fixtures to be U.L. listed specifically for use in commercial kitchen exhaust canopies and to comply with the requirements of the National Electrical Code.

PART 2 - PRODUCTS**2.1 MANUFACTURED UNITS**

- A. Canopy is to be sized as shown on the drawings.
- B. Canopy interior is to be fabricated of #18 ga. S/S where exposed, and enclosed by an integral makeup air shell fabricated of #18 ga. S/S where exposed.
- C. Makeup air shell fitted with perforated SS face.
- D. Full compliment of U.L. classified, accessible, S/S removable grease extractor. Provide proper S/S spacers and integral pitched gutter with removable cup located beneath baffle row.
- E. Vapor proof incandescent light fixtures on maximum 4'-0" centers factory installed and wired to junction box on top of canopy. All wiring to be outside the grease areas of exhaust canopy.
- F. Each canopy to be fitted with exhaust collars and supply collars. Exhaust collars to be fitted with U.L. listed fire damper assemblies.
- G. Top of makeup air shell fitted with anchors for 1/2" threaded rods. Hanger rods are furnished by installing contractor. Provide offset wall clip at rear for mounting.
- H. Factory installed liquid Ansul R-102 chemical fire suppression system providing surface, duct and plenum protection. System to consist of chemical tank mounted at location approved by local authorities as high up as possible to allow head clearance. System is to include all



necessary interconnecting piping and cable runs between the nozzles, fusible links, gas valve, manual release, and the location of the chemical cylinder. Install, where directed by local authorities, a remote manual release station. All exposed piping to be chrome plated or S/S jacketed.

- I. Micro-switch in chemical tank for shutoff of electric heated cooking appliances. Power shutdown devices and interwiring of same are by the electrical contractor. Electrical contractor to verify with local authorities the items of equipment requiring power shutdown. Provide gas shutoff valve for shutoff of all gas fired cooking appliances. Valve furnished loose to plumbing contractor for installation by him into incoming gas line. This contractor is to co-ordinate valve size and location with plumbing contractor.
- J. Ductwork to canopy shall consist of roof curb, roof top plenum assembly, inlet duct, and interwiring between exhaust fan, makeup air unit and central panel on wall. Roof curb fabricated of heavy gauge galvanized steel 8" high with welded corners and insulated with 1 1/2" fiberglass. Size to suit plenum assembly. Supply ductwork fabricated of #18 ga. galvanized steel, lined with 1/2" coated fiberglass. Finish exterior ductwork in grey enamel. Exhaust duct shall be fabricated of #16 ga. galvanized steel with all seams welded with a continuous external weld. Exhaust duct sized to provide 1500 FPM minimum velocity.
- K. Ventilator control panel for wall mounting with switches and indicator lights for system "on-off" and heat "on-off" functions, control dial for varying discharge air temperature and switch for hood light fixture.
- L. Necessary motor overload controls and starters for exhaust and supply fans, fully wired into systems. All controls mounted within rain tight cabinet.
- M. Approved Manufacturers:
 - 1. Greenheck
 - 2. Econ-Air
 - 3. K-Tech
 - 4. Captive Air

PART 3 - EXECUTION

3.1 FIELD QUALITY ASSURANCE

- A. Fire Extinguishing system and canopy is to be installed in full compliance with requirements of local authority having jurisdiction.
- B. Job site work shall be performed by or under the supervision of a qualified factory authorized Ansul dealer.
- C. Contractor to co-ordinate with architect and/or general contractor to determine exact placement of roof curb to avoid or adapt to physical obstructions and conditions.
- D. Canopy manufacturer shall dispatch a factory trained technician to the job site to start-up, adjust and balance system. He shall instruct the owner's agent in the care, operation and maintenance of the system.
- E. Type I Hood shall be installed with a clearance to combustibles of not less than 18", that is, unless the gypsum wallboard or 1/2" thick or thicker cementitious wallboard attached to noncombustible structures is provided with a smooth, cleanable, nonabsorbent and noncombustible material installed between the hood and the gypsum or cementitious wallboard over an area extending not less than 18 inches in all directions from the hood.

END OF SECTION 23 3813



SECTION 23 3815 – KITCHEN HOOD MAKE-UP AIR UNIT AND EXHAUST FAN**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

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

PART 2 - PRODUCTS**2.1 MANUFACTURED UNITS**

- A. Arranged to supply 100% outside air and have capability of raising air temperature a minimum of 65 deg. F.
- B. Direct gas fired with direct spark igniter and flame sensing rod. Combustion efficiency shall provide discharge air with an average concentration of less than 5 PPM of carbon monoxide.
- C. Makeup air unit with intake hood, filter section, cleanable filters, automatic outside air damper and mounting base.
- D. Necessary controls to monitor discharge temperature via a hood mounted dial control. Packaged wiring between hood and make-up air unit shall be provided.
- E. Unit fan and heat "off-on" shall be provided by switches with appropriate indicator lights mounted in ventilator control cabinet.
- F. Unit to be provided with contactors and proper motor protection and disconnects with single point electrical connection for the control of both exhaust and supply fans.
- G. Designed for outdoor operation, with hinged panels for easy servicing access to motor, drive, burners and control without the use of tools. Provide insulated cabinet with metal on heated air side.
- H. Supplied with a wide range burner having a modulating turndown ration of 30 to 1. Adjustable profile base plates shall be located upstream from blower and provided and sized to maintain the required velocity across the line burner. The burner assembly and gas manifold shall be completely prepiped and factory tested prior to shipment and controlled by a maxitrol modulating system.
- I. Exhaust fan:
 - 1. Spun aluminum upblast type
 - 2. UL rated for kitchen hood exhaust
 - 3. Adjustable belt drive
 - 4. Non-overloading wheel
 - 5. Motor is to be mounted outside exhaust airstream in a ventilated motor compartment.
- J. Approved Manufacturers:
 - 1. Greenheck
 - 2. Gaylord
 - 3. Reznor

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION 23 3815

SECTION 23 4100 – DISPOSABLE FILTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Furnish and install filters used in mechanical equipment.

PART 2 - PRODUCTS

2.1 HEAT PUMP FILTERS

- A. Filters shall be two inch thick throw-away type as recommended by Heat Pump Manufacturer.
- B. Build custom filter rack to adapt to standard size filters. Entire building heat-pumps to have no more than 3 filter sizes.
- C. Provide two complete sets of extra filters for all heat pumps at project completion.

END OF SECTION 23 4100

SECTION 23 5134 – FLUES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Furnish and install flues as described in Contract Documents.

PART 2 - PRODUCTS**2.1 FLUES**

- A. Sections shall be UL listed.
- B. Sections shall have:
 - 1. Outer jacket of aluminum-coated or galvanized steel.
 - 2. One inch minimum insulating air space.
 - 3. Inner gas carrying pipe of stainless steel.
 - 4. Capability of handling flue gas temperatures up to 1400 deg F on continuous basis.
- C. Furnish items which form part of assembly including but not limited to:
 - 1. Bracing and supports as recommended by Flue Manufacturer.
 - 2. Cleanout sections
 - 3. T-sections
 - 4. Necessary straight sections
 - 5. Ventilated roof thimble
 - 6. Flashing and counterflashing
 - 7. 'Backdraft preventer' installed at top of water heater and boiler flues.
- D. Approved Manufacturers:
 - 1. Metalbestos Model PS
 - 2. Metivent Model GTD
 - 3. Metal-Fab Inc All Fuel Chimney

2.2 VENT CAPS

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

END OF SECTION 23 5134

SECTION 23 5230 – GAS BOILER (FULTON)**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Furnish and install a Natural Gas Fired Fulton Pulse Combustion Hot Water Boiler or approved equal.
- B. Each unit shall be pulse combustion type complete with boiler fittings and automatic controls. The boiler, with all piping and wiring, shall be completely factory assembled with stainless steel combustion chamber as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with maximum water working pressure of 100 psi. Boiler shall also comply to CSD-1 Code requirements.
- C. Boiler shall be Firetube design, utilizing the principles of sealed combustion and fully condensing. The boiler, due to the nature of Pulse Combustion, shall be self aspirating requiring no forced or induced draft fan to supply air for combustion after ignition. Adequate openings shall be provided for access to the water side of the boiler. The boiler pressure vessel shall be completely insulated 2" minimum and encased in an 18 gauge metal cabinet with primer and finish coat of paint.
- D. The Fulton Pulse Combustion Boiler shall be AGAL Approved as a Direct Vent Boiler. Conventional chimney or stack is not required. The direct venting shall be in accordance with the Product Data Submittal Sheet. The boiler shall have the combustion air intake supply ducted in from the outside. This air intake supply ductwork shall also be in accordance with the Product Data Submittal Sheet.

1.3 BOILER FITTINGS

- A. Safety Valves shall be ASME Section IV and NBIC approved side outlet type. Their size and number shall be in accordance with Code requirements. Valves shall bear NBIC registration number.
- B. Temperature and pressure gauge shall be mounted on top of boiler.

1.4 PULSE COMBUSTOR EQUIPMENT

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



7. Diagnostic control module

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

1.5 OPERATING MANUAL

- A. Instructions for installation, operation, and maintenance of the boiler shall be contained in a manual provided with each boiler unit.
- B. A wiring diagram corresponding to the boiler shall be affixed to the control box cover.

1.6 START-UP

- A. Boiler shall be checked out and started up by a factory trained service technician. Provide complete start-up sheets and efficiency data in the M & O manuals. A copy of this report shall be filed with the Division of Building Safety.
- B. After installation, all boilers and pressure vessels shall be inspected by a State Commissioned Boiler Inspector and receive a certificate to operate. No boiler shall be put into service without this certificate.

END OF SECTION 23 5230

SECTION 23 5719 – PLATE AND FRAME HEAT EXCHANGERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Furnish and install heat exchanger as described in Contract Documents.

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Plate type heat exchangers with maximum pressure drop through heat exchanger of 5 psi.
- B. Framework, pressure plate and fixed plate shall be of heavy carbon steel painted with epoxy enamel.
- C. The heat exchanger corrugated channel plates shall be Type 304 stainless steel with nitrile gaskets. The gasket pattern on each channel plate distributes the fluid flow to alternate plate flow channels in the plate pack creating 100% counterflow resulting in high transfer effectiveness.
- D. Approved Manufacturers:
 - 1. Bell & Gossett
 - 2. Alfa-Laval

END OF SECTION 23 5719

SECTION 23 5720 - ENERGY RECOVERY VENTILATORS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Furnish and install energy recover ventilator unit as described in Contract Documents.

1.3 SUBMITTALS

- A. Energy Efficiency:
 - 1. Indicate Energy Efficiency Rating (EER) for equipment provided under work of this section
 - 2. Submit documentation for Energy Star qualifications for equipment provided under work of this Section.
- B. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
- C. Reports for aquatic toxicity testing of lubricants in accordance with ASTM D6081.

1.4 QUALITY ASSURANCE

- A. Energy Efficiency: Meet or exceed ASHRAE 90.1.
- B. Indoor Environmental Quality:
 - 1. Ventilation: Meet or exceed ASHRAE 62 and all published addenda.
 - 2. Filtration: Meet or exceed ASHRAE 52.
 - 3. Thermal Comfort: Meet or exceed ASHRAE 55.
 - 4. Maintain positive pressure within the building.

PART 2 - DESCRIPTION**2.1 SYSTEM DESCRIPTION**

- A. Units capable of transferring sensible energy as listed to the equipment schedule.
- B. Flat plate heat exchanger to be factory installed in unit.
- C. Unit is designed to be used as a stand-alone heat recovery ventilator or as a heat recovery component in a dedicated HVAC system or as a complete ventilation HVAC unit.

2.2 QUALITY ASSURANCE

- A. Unit shall be constructed in accordance with CSA C22.2 and UL 1812 and shall carry the (C)UL or (C) ETL label of approval.
- B. Insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.
- C. Airflow data shall comply with AMCA 210 method of testing.

2.3 DELIVERY, STORAGE, AND HANDLING

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

2.4 WARRANTY

- A. Unit shall have a 2 year warranty on all parts not including flat plate heat exchanger.
- B. Flat plate heat exchanger shall have a 15 year warranty.
- C. Manufacturers without a 15 year warranty shall supply an extra flat plate heat exchanger for the entire unit. Flat plate heat exchanger to be turned over to the Owner at the time of delivery for stocking purposes.

PART 3 - PRODUCTS

3.1 EQUIPMENT

- A. General
 - 1. Packaged, heat recover ventilator consisting of flat plate heat exchanger, ventilation air fan, exhaust air fan, necessary dampers, temperature sensors, and microprocessor controls.
- B. Unit Cabinet
 - 1. Cabinet shall be constructed of 20 gauge G-90 galvanized steel with 12 or 16 gauge galvanized frame.
- C. Access
 - 1. Access to all components that require servicing shall be provided through sealed and easily removable access panels(s).
 - 2. Flat plate heat exchanger shall be easily removable from the unit.
 - 3. All parts must be serviceable in less than 7 minutes.
- D. Flat Plate Heat Exchanger
 - 1. Aluminum flat plate heat exchanger designed to meet NFPA 90A requirements for smoke development and flame spread.
 - 2. Energy recovery effectiveness values shall be tested in accordance with ASHRAE 84 and ARI Standard 1060.
- E. Operating Characteristics
 - 1. Unit shall be capable of providing a constant volume of air at a specified external static pressure at all fan operating speeds.
- F. Blowers
 - 1. Fan ratings are based on tests made in accordance with AMCA Standard 210.
 - 2. Blowers must be selected to operate on a stable efficient part of the fan curve when delivering air quantities scheduled against static of the system.
 - 3. Fan blades shall be statically and dynamically balanced and tested prior to shipment.
 - 4. Fan shall be provided with internal vibration isolation mounts.
 - 5. Fan discharge shall be as noted on the plans.
 - 6. Fans shall have sealed ball bearings with L10 life expectancy for belt drive units.
- G. Motors
 - 1. Motors shall be continuous duty, permanently lubricated, and matched to the fan loads.
 - 2. Motors shall meet new EPAC regulations for efficiency and shall have inverter spike resistance wire for protection.
 - 3. Motor selection must include a 15% service factor.

- H. Electrical Requirements
 - 1. Units shall have single point power connection only.
 - 2. All controls shall be factory mounted and wired, requiring only field installation of remote sensing devices and wiring to unit mounted terminal strips.
- I. Filters
 - 1. Toxicity/IEQ: Provide filtration media with a Minimum Efficiency Reporting Value (MERV) of 13 as determined by ASHRAE 52.2. Coordinate with work of Section 01352 - IAQ Management.
 - 2. Biobased Content: Minimum 95 percent biobased material.

3.2 CONTROLS

- A. General
 - 1. Unit shall be provided with a factory mounted and factory wired microprocessor control.
 - 2. All service connectors shall be quick disconnect type.
 - 3. Unit circuitry shall allow the following operational characteristics:
 - a. Dry contacts for occupancy control
 - b. Remote fan interlock on call for ventilation
 - c. Selection of low or high speeds
 - d. Remote wall control contacts
 - e. Unoccupied recirc contacts

3.3 OPTIONS

- A. Defrost
 - 1. Damper/Recirculation Defrost Cycle - unit shall be equipped with recirculation defrost from forming on the flat plate heat exchanger and prevent negative pressure from occurring in building envelope.
- B. Double Wall Construction
 - 1. Cabinet shall be insulated throughout and lined with a 26 gauge galvanized wall for easy cleaning, prevention of potential for microbial growth, and elimination of potential puncture of insulation membrane.
- C. Pre-paint Cabinet
 - 1. Unit cabinet shall be minimum 20 gauge pre-painted galvanized steel.
- D. Access Panels
 - 1. Unit shall have quick opening type fasteners to allow for easy access.

3.4 ACCESSORIES

- A. Night Set Back
 - 1. 24 hour programmable timer shall be included for occupied/unoccupied time settings.
- B. CO₂ Controller
 - 1. Non-dispersed infra-red control shall be provided to trigger ventilation at levels above 1000 ppm of CO₂

3.5 ACCEPTABLE MANUFACTURERS

- A. Venmar
- B. Renewaire.
- C. Greenheck
- D. Semco



PART 4 - EXECUTION

4.1 FILTERS

- A. Provide one extra set of filters.

END OF SECTION 23 5720

SECTION 23 6514 – COOLING TOWER**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Furnish and install Cooling Tower, Water Treatment, Remote Sump and Tower Pump as described in Contract Documents.

PART 2 - PRODUCTS**2.1 COOLING TOWER**

- A. General:
 - 1. Fiberglass cooling tower.
 - 2. Unit shall be single cell, induced draft, vertical discharge, counter-flow design, utilizing fiberglass reinforced polyester (FRP) materials in basin and casing of cooling tower structure.
 - 3. Tower shall be supplied as a field erected package complete with assembly and necessary components and accessories as required for complete installation.
- B. Cold Water Basin:
 - 1. Cooling tower basin shall be molded of corrosion-resistant fiberglass reinforced polyester (FRP) material to assure durability and long life.
 - 2. Basin shall be a multi-segment structure, equipped with provisions for connections to hot water inlet, cold water outlet, and basin drain for remote sump application.
- C. Tower Casing:
 - 1. Cooling tower casing shall be molded of corrosion-resistant fiberglass reinforced polyester (FRP) material to assure durability and long life.
 - 2. Casing shall be a multi-segment type, providing easy access to the fill media.
 - 3. Casing panels shall be capable of withstanding wind loads of at least thirty (30) pounds per square foot.
- D. Fans:
 - 1. Fan blades shall be slow speed, aerodynamically designed, propeller type with adjustable pitch to provide efficient use of power and to assure quiet operation.
 - 2. Fan blades and related hub shall be constructed of a special cast aluminum alloy material for corrosion-resistance and maintenance free operation.
- E. Fan Motor/Drive System:
 - 1. Multi-blade propeller type fan blade shall be driven by a special V-belt reducer unit to provide proper speed and to assure constant air flow thru fill media.
 - 2. Reducer assembly shall have provisions for belt adjustment and related maintenance without disassembly of drive system.
 - 3. Fan motor shall be a single speed totally enclosed, air-over (TEAO), permanently lubricated, ball bearing type, with 1.15 service factor, suitable for outdoor service.
 - 4. Motor/V-belt reducer and fan assembly shall be supported on a structural steel support protected by hot-dip galvanized coating.

5. Suitable fan guard shall be included.
- F. Fill:
1. Cooling tower fill shall be PVC (polyvinyl chloride) of corrugated and embossed design to provide maximum air to water contact for optimum heat transfer efficiency.
 2. Fill shall be provided in a circular configuration to enable easy replacement if required.
 3. The PVC material shall be fire resistant, and shall meet the provisions of ASTM Standard E-84 with a flame spread rate of 25.
 4. Fill must withstand a maximum water temperature of 130 deg. F. and be resistant to rot, decay, or biological attack.
- G. Water Distribution: Water distribution shall be provided through a rotating sprinkler head system. Water from the inlet connection shall be forced thru the rotating sprinkler system under pump pressure and distributed evenly over the entire fill area. The rotating sprinkler head and related piping shall be non-ferrous, non-corrosive and self-rotating at low head loss. All sprinkler pipes shall have removable end caps for maintenance purposes.
- H. Eliminators: Special drift eliminators shall be attached to the sprinkler pipes to effectively reduce drift (carry-over) from the airstream. Drift loss shall be limited to 0.2 percent at design/operating conditions. Eliminators shall be of non-ferrous, non-corrosive materials.
- I. Hardware & Finish: All metal fasteners (nuts, bolts, washers) shall be stainless steel to resist corrosion. All supporting steel structure shall be Stainless Steel.
- J. All fiberglass reinforced polyester materials (FRP) shall contain UV (ultra-violet) inhibitors, fire retardant fillers to satisfy ASTM E-84-Class A and an exterior gel coat to protect the structural integrity of the basin and casing. Exterior surface shall have a cosmetically appealing surface that is durable, long lasting and eliminates the need for other finishing.
- K. The tower will be provided with an OSHA approved ladder adequate to allow inspection and accessibility to the fan/motor and upper portion of the tower cell. In addition, a suitable wire-grill fan guard will be provided. These items shall be protected with a hot-dip galvanized coating.
- L. Air inlet louvers of a PVC plastic material shall be provided to prevent objects from entering the water basin.
- M. Color – Towers to be Gray or Tan Fiberglass – No Exceptions.
- N. Approved Manufacturers:
1. RSD
 2. AMCOT
 3. Protec
- O. Water Treatment:
1. Complete packaged water treatment system for the cooling tower.
 2. Submit with cooling tower submittal.
 3. Approved Manufacturers:
 - a. Chemicator system by V.O.P. with six refill tubes.

2.2 REMOTE SUMP

- A. Sumps shall be constructed of the following metal thickness.
1. Rectangular:
 - a. Sides up to 5 feet wide x 6 feet tall shall be 3/16 inch plate steel.
 - b. Sides larger than 5 feet wide or 6 feet tall shall be 1/4 inch plate steel.



2. Round:
 - a. Up to 6 feet round x 6 feet high side and bottom shall be 3/16 inch plate steel rolled to diameter.
 - b. Larger than 6 feet round or 6 feet high sides and bottom shall be 1/4 inch plate steel rolled to diameter.

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

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

END OF SECTION 236514

END OF DIVISION 23