

## **DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING**

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## **SECTION 23 05 01**

### **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.

##### 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. "2018 International Building Code", "2018 International Mechanical Code", "2018 International Plumbing Code" and "2018 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

## **SECTION 23 05 53**

### **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. 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

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

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

END OF SECTION

## **SECTION 23 07 12**

### **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. Refrigerant Piping
  - 3. Fire Stopping

##### 1.3 QUALITY ASSURANCE

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

END OF SECTION

## **SECTION 23 07 16**

### **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

## **SECTION 23 07 17**

### **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

## **SECTION 23 07 18**

### **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. Certaineed Ultralite 150 Certa Edge Coat
  - 2. Knauf - Type M
  - 3. Manville - Lina-Coustic
  - 4. Owen Corning Fiberglas - Aeroflex



## 2.2 ADHESIVE

- A. Water Base Type:
  - 1. Cain - Hydrotak
  - 2. Duro Dyne - WSA
  - 3. Kingco - 10-568
  - 4. Miracle - PF-101
  - 5. Mon-Eco - 22-67
  - 6. Techno Adhesive - 133
  
- B. Solvent Base (non-flammable) Type:
  - 1. Cain - Safetak
  - 2. Duro Dyne - FPG
  - 3. Kingco - 15-137
  - 4. Miracle - PF-91
  - 5. Mon-Eco - 22-24
  - 6. Techno Adhesive - 'Non-Flam' 106
  
- C. Solvent Base (flammable) Type:
  - 1. Cain - HV200
  - 2. Duro Dyne - MPG
  - 3. Kingco - 15-146
  - 4. Miracle - PF-96
  - 5. Mon-Eco - 22-22
  - 6. Techno Adhesive - 'Flammable' 106

## 2.3 FASTENERS

- A. Adhesively secured fasteners not allowed.
  
- B. Approved Manufacturers:
  - 1. AGM Industries Inc - "DynaPoint" Series DD-9 pin
  - 2. Cain
  - 3. Duro Dyne
  - 4. Omark 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

## **SECTION 23 07 20**

### **REFRIGERANT 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 above ground refrigerant suction piping and fittings, including thermal bulb, from thermal expansion valve as described in Contract Documents.

##### 1.3 QUALITY ASSURANCE

- A. Insulation shall have flame-spread rating of 25 or less and a smoke density rating of 50 or less as tested by ASTM E-84 method.
- B. Ratings:
  - 1. Upper rating of =210 deg. F.
  - 2. Lower rating of -110 deg. F.
  - 3. UV stabilized for ten year life.
  - 4. Thermal conductivity of 0.24.
  - 5. Water vapor transmission of .03 perms per inch.
  - 6. Material to be polyolefin food grade.

#### **PART 2 - PRODUCTS**

##### 2.1 FLEXIBLE FOAMED PIPE INSULATION

- A. Thickness:
  - 1. 1/2 inch for one inch outside diameter and smaller pipe.
  - 2. 3/4 inch for 1-1/8 through 2 inch outside diameter pipe.
  - 3. One inch for 2-1/8 inches outside diameter and larger pipe (two layers of 1/2 inch).
  - 4. One inch sheet for fittings as recommended by Manufacturer.
- B. Approved Manufacturers:
  - 1. Armaflex
  - 2. Halstead "Insul-tube"
  - 3. Rubatex
  - 4. Therma-Cel

##### 2.2 JOINT SEALER

- A. Approved Manufacturers:
  - 1. Armaflex 520

2. BFG Construction Adhesive #105
3. Therma-Cel 950.

### 2.3 MANUFACTURED UNITS

- A. Nominal 3/4" wall thickness
- B. Approved Manufacturers:
  1. ImcoLock Pipe Insulation
  2. or approved equal

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install insulation in snug contact with pipe and in accordance with Manufacturer's recommendations.
- B. Insulation shall be slipped onto pipe prior to connection or applied after pipe is installed, at contractor's option.
- C. Close butt joints and miter joints.
  1. Approved Manufacturers:
    - a. IMCOA's Fuse-Seal joining system
    - b. or factory approved contact adhesive
- D. Insulation shall be installed according to manufacturer's recommended procedures.
- E. Exterior exposed Insulation shall be finished with two coats of factory approved finish. Color shall be selected by the Owner's representative.
- F. Stagger joints on layered insulation.
- G. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.
- H. Seal joints in insulation.
- I. Insulate flexible pipe connectors.
- J. Insulate thermal expansion valves with insulating tape.
- K. Insulation exposed outside building shall have "slit" joint seams placed on bottom of pipe.
- L. Insulate fittings with sheet insulation and as recommended by Manufacturer.

END OF SECTION

## **SECTION 23 08 00**

### **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

## **SECTION 23 09 53**

### **TEMPERATURE CONTROLS**

#### **PART 1 - SYSTEM OVERVIEW**

##### 1.1 DDC CONTROL SYSTEM

- A. Statement of Intent: The intent of this specification is to provide a high-quality Direct Digital Control system at Reed Gymnasium for integration into the current ISU WebCTRL™ front end. In order to maintain seamless interface and consistency of user screens all new control hardware must be programmed using the Eikon™ control programming utility. System must continue to have realtime presentation of these programs showing current operating parameters and conditions. Graphical User Interface screens must be developed using ViewBuilder™ graphics development software.
- B. Specification Compliance: These specifications are intended to provide a minimum capability for the DDC system. Manufacturer's data sheets included in the submittals will be reviewed to verify significant hardware and software system features. Key system features must be documented by manufacturer's data sheets in the submittals or by demonstration of an existing installation. Anyone wishing approval to bid must coordinate with the Mechanical Engineer and School District personnel not later than 10 days prior to bid date for a system demonstration of integration capabilities to existing front end software as noted above.
- C. Approved DDC Contractor and System
  - 1. DDC Control System shall be:
  - 2. Automated Logic WebCTRL by Clima-Tech Corporation
  - 3. Johnson Controls

##### 1.2 SCOPE OF WORK

- A. Control Hardware and Software: Automatic Temperature Control Contractor shall be responsible to furnish and install all control hardware and software necessary for complete DDC control system as specified. ATC contractor shall furnish all modules, temperature sensors, flow sensors, humidity sensors, IAQ sensors, control valves, control valve actuators, dampers, damper actuators and any other items necessary for a complete system and sequence of control.
- B. Specifically the ATC Contractor shall furnish the following:
  - 1. Individual unitary control modules for each unitary system:
    - A. Roof Top Units
    - B. Furnaces
- C. Individual control modules for all non unitary air handlers or package units:
  - 1. Dry Coolers
- D. General purpose modules for control of central fan, pump, chiller, boiler or tower operation:
  - 2. Hot Water Systems
  - 3. Steam Systems

**SECTION 23 09 00**

**COMMISSIONITN OF HVAC**

PART 1 GENERAL

1.1 Summary

- A. Attention is directed to the printed form of Contract and General Conditions and Supplementary Conditions which are hereby made a part of this Section of the Specifications.
- B. Furnish all labor, materials, equipment and services necessary to provide the owner with fully functional HVAC systems.
- C. Commissioning: Commissioning (Cx) is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet the defined objectives and criteria set by the Owners.
- D. Commissioning Team: The members of the Cx team consist of the owner's contracted commissioning authority (CxA), the owner's representative or construction manager (CM), the general contractor (GC), the architect (Arch) and the design engineers (Engs), the mechanical Contractors (MC), the electrical contractor (EC), the testing and balancing (TAB) contractor, the control contractor (CC), the facility operating staff, and any other subContractors or suppliers of equipment. The CxA directs and coordinates the project Cx activities and reports to the owner. All team members work together to fulfill their contracted responsibilities and meet the objectives of the contracted documents. Commissioning Shall:
  - 1. Verify that applicable equipment and systems are installed according to the contract documents, manufacturer's recommendations, and industry accepted minimum standards and that they receive adequate operational checkout by installing Contractors.
  - 2. Verify and document proper performance of equipment and systems.
  - 3. Verify that O&M documentation left on site is complete.
  - 4. Verify that the owner's operating personnel are adequately trained.
- E. The Cx process does not take away from or reduce the responsibility of the system designers or installing Contractors to provide a finished and fully functional product. Furthermore, it doesn't not remove any responsibilities, products or requirements of other specification sections. This includes equipment startup by manufacturer trained personnel.
- F. The general or HVAC contractors are not required to provide the CxA. An independent, third party commissioning agent has been retained by the State of Idaho. Though the contractor is not required to provide a commissioning agent,

requirements for participation in the commissioning process are included in this specification.

## 1.2 DESCRIPTION OF WORK

- A. The work of this Section shall include and provide all labor, tools, materials and equipment necessary for the CxA to verify installation and performance of the HVAC and Controls systems.

## 1.3 RELATED WORK IN OTHER SECTIONS & REFERENCED STANDARDS

- A. The following related work shall be furnished or performed under other Sections of these Specifications:
  - 1. Section 019113 – GENERAL COMMISSIONING REQUIREMENTS
  - 2. Section 019114 – COMMISSIONING PLAN
  - 3. Section 220900 – COMMISSIONING OF DOMESTIC WATER SYSTEMS
  - 4. Section 260800 – COMMISSIONING OF LIGHTING AND CONTROLS
- B. Commissioning Plan documentation is included by reference for information only.
- C. ASHRAE Standard 202-2018
- D. IECC 2015

## 1.4 DEFINITIONS

- A. Commissioning Plan: The detailed process of checking and testing procedures, sequences of events, schedules, staffing plans, and management or administrative procedures required to provide a comprehensive coordinated approach for commissioning the systems and equipment described herein.
- B. CxA: Commissioning Authority. The main point of contact for the commissioning process and third-party technical representative of the owner. The Commissioning Authority will manage all commissioning activities on behalf of the Owner and will serve as the Owner's agent in review and approval of commissioning related services.
- C. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- F. Commissioning Representatives: Those members of the Contractor's staff, Sub-contractor's staff, Owner's staff, Architect's staff, or Owner's independent contractor assigned to participate in the commissioning process.
- G. Commissioning Manager: The Commissioning Representative of the Contractor and/or commissioning team, to manage and lead the commissioning effort on behalf of the Contractor and/or commissioning team.



- H. Commissioning Procedures: A series of checks, tests, and operational procedures, applied in specific sequences, to each system or equipment component to be commissioned and intended to demonstrate full system installation, performance, and functionality, in accordance with the design intent. The term "procedures" shall be used throughout this specification and the Project Commissioning Plan in reference to these checking, testing, and operational procedures.
- I. Pre-Functional Test: A test, or tests, of the static function and operation of equipment and systems using manual (direct observation) by the installing contractor prior, during and post-equipment startup. Systems Pre-Functional Performance Testing is meant to verify the as-built systems ability to operate trouble free in at least a limited fashion prior to TAB and Systems Functional Performance testing.
- J. Functional Performance Test: A test, or tests, of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods meant to commence following the completion of startup/programming and Systems Pre-Functional Testing. Systems Functional Performance Testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint) performed by the Commissioning Agent with support from the contractor as needed. Systems are tested under various modes, such as during normal occupied, unoccupied or emergency modes. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Manufacturer startup and control system checkout is not considered Systems Functional Performance Testing. The Commissioning Agent develops the Systems Functional Performance Test Procedures in a sequential written form, coordinates, witnesses, and documents the actual testing. Systems Functional Performance Tests are performed after startups, control systems are complete and operational, TAB functions and Pre-Functional Checklists are complete.
- K. Pre-Functional Checklist: A list of items in the form of a checklist provided by the Commissioning Agent to the Contractor that require inspection and elementary component tests conducted to verify proper installation of equipment. The contractor is required to perform this work, populate checklist forms and submit them to the Commissioning Authority prior to scheduling functional testing. Pre-Functional Checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation. However, some Pre-Functional Checklist items entail simple testing of the function of a component, a piece of equipment or system which may have been completed during manufacturer startup and programming. The term "Pre-Functional" refers to before Systems Functional Performance Testing. Pre-Functional Checklists augment and are combined with the manufacturer's startup checklist and the Contractor's Quality Control checklists.
- L. Commissioning Plan: The detailed process of checking and testing procedures, sequences of events, schedules, staffing plans, and management or administrative procedures required to provide a comprehensive coordinated approach for commissioning the systems and equipment described herein.

- M. Commissioning Authority: The Commissioning Representative of the Owner. The Commissioning Authority will manage all commissioning activities on behalf of the Owner and will serve as the Owner's agent in review and approval of commissioning related services.
- N. System, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

#### 1.5 INTENT

- A. It is the intention of this Specification is to require the Contractors performing work to cooperate with the CxA, to furnish all labor and equipment and measuring devices, to perform required measurements and tests to verify that the installed equipment and systems are performing in accordance with the construction documents.
- B. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating or construction management.
- C. HVAC system installation, start-up, testing and balancing, preparation of O&M manuals, and operator training are the responsibility of the HVAC Contractor, with coordination by the General Contractor, Construction Manager or other entity acting under the requirements of Division 1. Observation, verification and Cx are the responsibility of the CxA who is to be assisted by installing Contractors in system operation as needed. The Cx process does not relieve Contractors from the obligations to complete all portions of work in a satisfactory and fully operational manner, nor does Cx remove any obligation the trades have for operation and maintenance manuals and training.

#### 1.6 HVAC CONTRACTOR REQUIREMENTS

- A. Cx, Pre-Functional and Functional testing as defined by ASHRAE standard 202-2018 are mandatory requirements of this project. Provide any assistance needed to fully test systems in accordance with testing protocols.
- B. All applicable equipment submittals shall be forwarded to the CxA for review.
- C. No Functional Testing shall commence until the completion and submission of the manufacturer startup checklists and populated pre-functional checklists to the CxA. The CxA will provide blank pre-functional testing forms for the contractor to populate. Pre-functional testing forms shall be provided to the CxA in submittal form.
- D. No Functional Testing shall commence until all systems TAB is complete. Functional testing may commence, at the discretion of the CxA, once TAB is complete however only conditional acceptance can be achieved until the final TAB report is provided by the contractor to the CxA for review. Only after review and acceptance of the TAB report and tested values can final acceptance be

achieved. The owner may elect to wait until final acceptance is achieved to consider the project substantially complete.

- E. The Cx responsibilities applicable to mechanical contractor and appropriate subcontractors are as follows:
1. Provide startup by manufacturer trained personnel for all equipment in the contracted scope.
  2. Assist and cooperate with the Testing and Balancing (TAB) contractor and the CxA by:
    - a. Putting all equipment and systems into operation and continuing the operation during each working day of TAB and Cx as required.
    - b. Including cost of sheaves, belts, and filter changes that may be required by TAB.
    - c. Providing clearances for test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing.
    - d. Providing temperature and pressure taps according to the Construction Documents for TAB and Cx testing.
    - e. Assist the TAB in the location and operation of all volume, control, and fire/smoke dampers.
  3. List and clearly identify on the as-built drawings the locations of all P/T plugs, air-flow stations gauges, meters, sensors and all other such measure and verification devices.
  4. Prepare a preliminary schedule for all pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.
  5. Notify the GC when pipe and duct system testing, flushing, cleaning, power distribution and startup of each piece of equipment and TAB will occur. Be responsible to notify the GC, ahead of time, when Cx activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that Cx processes are executed and that the CxA and GC both have the scheduling information needed to efficiently execute the Cx process.
  6. Attend Cx scoping meetings and other meetings necessary to facilitate the Cx process.
  7. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, together during equipment submittals to the CxA for review and approval. See this specification section for additional information and requirements for the O&M manuals.

8. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
9. Review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
10. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the PFTs from the CxA for all commissioned equipment. Submit to CxA for review and approval prior to startup.
11. During the startup and initial checkout process, execute the Mechanical related portions of the PFTs for all commissioned equipment. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
12. Address current outstanding issue log items before functional testing. Air and Water Pressure Testing and Air & Water Testing and Balancing (TAB) shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
13. Complete Prefunctional Test Checklists (PFTs) provided by the CxA and return these to the CxA.
14. Provide access for equipment to be tested, such as removing ceiling tiles.
15. Provide skilled technicians to execute starting of equipment and to execute the pre-functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.
16. Provide skilled technicians to assist with functional performance testing under the direction of the CxA for specified equipment outlined in the Cx Plan. Assist the CxA in interpreting the monitoring data, as necessary.
17. Correct deficiencies (differences between specified and observed performance). The CxA will provide one (1) functional retest of commissioned equipment at no additional charge to the contractor(s). If repeated failures of the equipment and/or system require retest beyond the first retest, the contractor (s) will be back charged for the time of the CxA required to complete the additional retesting.
18. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions. Provide assistance, cooperate and provide required materials to others as directed by the GC (and CxA) in the compilation of the O&M manuals. Prepare draft versions of the O&M Manual for use as the training syllabus.

19. During construction, maintain as-built red-line drawings for all drawings and final as-builts for contractor-generated coordination drawings. Update after completion of Cx (excluding deferred testing).
  20. Provide Training Plan and training of the Owner's operating staff using expert qualified personnel, as specified. Use the draft O&M manual as the training manual.
  21. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
  22. Attend Cx coordination meetings and provided assistance and cooperate in the preparation of a Cx schedule with the GC and CxA.
  23. Cx Tasks shall be performed by the same personnel who were involved in the installation and are familiar with the equipment.
  24. During the Warranty Period execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications and correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- F. The Cx responsibilities applicable to the TAB Contractor in addition to those which apply in (A) are as follows:
1. Prior to starting TAB, submit to the GC the qualifications of the site technician for the project as required by division 23 specifications. The owner, EOR and/or CxA will approve the site technician's qualifications for this project (if TAB is provided by the GC or subcontractor).
  2. Meet with the CxA and GC and submit the outline of the TAB plan and approach for each system and component to the CxA, GC and the controls contractor prior to starting TAB. The submitted plan will include:
    - a. Certification that the TAB contractor understands the Cx requirements.
    - b. An explanation of the intended use of the building control system for TAB. The controls contractor will comment on feasibility of the plan.
    - c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced.
    - d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
    - e. Final test report forms to be used.

- f. Procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.
  - g. Details of how *total* flow will be determined
  - h. The identification and types of measurement instruments to be used and their most recent calibration date.
  - i. Specific procedures that will ensure that water systems are operating at the lowest possible pressures and provide methods to verify this.
  - j. Details regarding specified deferred or seasonal TAB work.
  - k. Details of any specified false loading of systems to complete TAB work.
  - l. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
3. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.
  4. Provide the CxA with any requested data, gathered, but not shown on the draft reports.
  5. Provide a final TAB report for the CxA with details, as in the draft.

## 1.7 RESPONSIBILITY OF THE THIRD-PARTY COMMISSIONING AUTHORITY

- A. Organize and lead the Cx team.
- B. Prepare a construction-phase Cx plan. Collaborate with Contractors and with subContractors to develop test and verification procedures. Include design changes and scheduled Cx activities coordinated with overall Project schedule. Identify Cx team member responsibilities, by name, firm, and trade specialty, for performance of each Cx task.

- C. Review and comment on submittals from Contractors for compliance with the OPR, BOD, Contract Documents, and construction-phase Cx plan. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the OPR and BOD.
- D. Convene Cx team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the Cx processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The CxA shall prepare and distribute minutes to Cx team members and attendees within five workdays of the Cx meeting.
- E. At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the Cx activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; and Project completion.
- F. Observe and verify construction and report progress and deficiencies. In addition to compliance with the OPR, BOD, and Contract Documents, verify systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.
- G. Prepare project-specific test and verification procedures and checklists.
- H. Schedule, direct, witness, and document tests and verifications.
- I. Compile test data, verification reports, and certificates and include them in the systems manual and Cx report.
- J. Develop custom pre-functional and functional testing protocol for review by interested parties.
- K. Perform functional testing with assistance by appropriate contractors.
- L. Certify date of acceptance and startup for each item of equipment for start of warranty periods.
- M. Review project record documents for accuracy. Request revisions from Contractor to achieve accuracy. Project record documents requirements are specified in Division 1.
- N. Review and comment on operation and maintenance documentation and systems manual outline for compliance with the OPR, BOD, and Contract Documents. Operation and maintenance documentation requirements are specified in Division 1.
- O. Review operation and maintenance training program and provide assessment and feedback on the completeness of the maintenance training program requirements. Operation and maintenance training is specified in Division 1.

- P. Assemble the final Cx documentation, including the Cx report and Project Record Documents.

#### 1.8 SYSTEMS TO BE COMMISSIONED

- A. HVAC System
  - 1. Rooftop Heating & Air Conditioning Units
  - 2. Exhaust Fans
  - 3. Furnace, Condensing Unit, electric heaters, split systems and kitchen systems
  - 4. General Airside Systems infrastructure including piping, ductwork, insulation, fittings, etc.
  - 5. Local and DDC based controls
  - 6. Installation Quality
  - 7. Overall HVAC Functionality
- B. No Functional Testing shall commence until all Prefunctional Checklists are completed and returned to the CxA.

#### 1.9 RECORD DRAWINGS

- A. Record drawings shall be kept on the job site and up dated continuously by the Contractor as the work progresses
- B. Record drawings shall show exact locations and sizes of all the work to be concealed. Especially note the location of the valves, volume dampers, fire dampers, etc.
- C. Non-availability of the updated record drawings or inaccuracies therein shall be grounds for cancellation and/or postponement of any final verification by the Engineer.

#### 1.9 COMMISSIONING APPROACH

- A. General
  - 1. The commissioning approach shall include a series of checks, tests, and operational procedures, applied in specific sequences, to each system or equipment component to be commissioned.
  - 2. The contractor shall perform startup tests in accordance with manufacturer's requirements and pre-functional testing in accordance with Commissioning Authority supplied checklists utilizing members of the construction staff and representatives of the equipment and system manufacturers



who are fully knowledgeable of the equipment and systems installation and operation.

3. The HVAC contractor is required to fill out the pre-functional testing forms provided by the Commissioning Agent. The Commissioning agent may observe certain pre-functional tests and their discretion.
4. The specific commissioning procedures required are described in the Project Commissioning plan found in section 01 91 14 . These procedures shall be performed in a specific sequence as described in the Project Commissioning Plan. The sequenced application of the procedures is intended to provide a step-wise development, proceeding from the individual component level, to the system level, and ultimately to the multiple integrated level of system operation. This sequencing approach will require certain procedures to be performed earlier in the construction process than for non-commissioned construction, and is intended to help ensure that the installation is free of defects at the earliest opportunity, allowing increased time for correction or modification if defects or performance issues are found.

## PART 2 - PRODUCTS

### 2.1 Test Equipment

- A. Each subcontractor shall furnish all the equipment and labor to perform the systems and equipment installed under their section. For example, the mechanical and electrical Contractors shall ultimately be responsible for all standard testing equipment for the mechanical, lighting and power systems, controls systems, plumbing systems except for equipment specific to and used by TAB in their Cx responsibilities.
- B. Stand-alone datalogging equipment shall be provided by the CxA as needed.
- C. BMS/DDC tied datalogging equipment and software can be used for Cx at the discretion of the CxA and shall be considered the property of the Owner.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available where applicable.
- E. Refer to the Cx Plan for details regarding equipment that may be required to simulate required test conditions.

## PART 3 - EXECUTION

### 3.1 SUBMITTALS

- A. Contractors shall provide submittal documentation for systems to be commissioned indicated herein and in the Cx Plan.

- B. Mechanical contractor shall provide documentation that that includes results of static testing as required by all Division 23 specifications.
- C. Mechanical Contractor shall provide all manufacturer based pre-startup, startup and other equipment specific pre-testing documentation.
- D. Mechanical Contractor shall perform pre-functional testing and provide populated prefunctional checklists to the CxA (Blank forms to be provided by CxA).

### 3.2 PRE-COMMISSIONING WORK SESSION & KICKOFF MEETING

- A. The mechanical subcontractor shall participate in the pre-commissioning work session to review the CxA's developing Commissioning Plan. The work session shall be held prior to Lighting rough-in.
- B. The work session shall be held at the Contractor's principle place of business or at the job site. The GC, CxA, appropriate subcontractors and representatives of the owner shall be scheduled for attendance as a minimum. Sub-contractor representatives of the principle trades involved in the commissioning process should also be in attendance and may be scheduled for attendance at the discretion of the CxM.
- C. The GC shall record participant comments and distribute minutes of the meeting to all parties involved.
- D. The GC shall schedule and chair a commissioning kickoff meeting review the CxA's testing protocols, revisit the commissioning plan and review scheduling for upcoming testing. The work session shall be prior to startup of major equipment.
- E. The GC shall schedule and the appropriate subcontractors shall participate in the kickoff meeting held separately from the work session.
- F. Mechanical contractor(s) shall participate in both the work session and kickoff meeting.

### 3.3 STARTUP

- A. The HVAC contractor(s) shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in the Cx Plan. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents and manufacturer requirements. The Cx procedures and pre-functional and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA, GC or Owner.

### 3.4 CONTROLS TESTING PREPARATION AND VERIFICATION

- A. The Cx responsibilities of the Controls Subcontractor in preparation for Functional Testing are:
  - 1. Sequences of Operation Submittals: The Controls Contractor shall send to the CxA complete controls submittals. Submittals of control drawings

shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. See Division 1 for complete details.

2. Points List: The Controls Contractor shall send to the CxA a draft points list as soon as it is available but no later than two months prior to occupancy. This shall be updated as often as required. A complete "as-built" points list shall be sent at the end of the project. See Division 1 for complete required contents of the points list.
3. Point-To-Point Checks – The Controls Contractor is required to perform their own point-to-point checks and provide verification to the CxA prior to the HVAC contractor scheduling functional testing.
4. Notification of Operation: The Controls Contractor shall notify the CxA when each piece of equipment, panel or sub-panel is under automatic control and may be viewed in operation, prior to final functional testing.
5. The Controls Contractor shall review all CxA provided functional test procedures. The receipt of the procedures by the contractor constitutes certification that the contractor has reviewed the procedures and confirmed they are safe and will not harm any equipment or systems. Any subsequent damage incurred as a result of conducting the documented verification shall be the responsibility of the contractor.

### 3.5 TAB

- A. Refer to the TAB responsibilities above and in the TAB specification section.

### 3.6 PRE-FUNCTIONAL TESTING

- A. Prior to the beginning of the commissioning and testing specified under this section, the HVAC subcontractor adjust and check operation and performance of the systems and equipment installed under their respective sections.
- B. At the discretion of the CxA the sub systems may be required to be tested prior completion of the entire system.
- C. Provide populated forms to the CxA in submittal form.
- D. Without limiting the following work shall be performed:
  1. Verify and document that the systems and equipment are installed and functioning in accordance with the OPR and contract documents. The as-built drawings and operating manuals reflect the as built conditions.
  2. The systems shall be started and their performance shall be checked and compared with the manufacturers requirements as well as design documents.
  3. Blank Pre-functional checklists shall be provided by the CxA.

4. Any system or equipment which is does not pass manufacturer startup requirements and Pre-functional testing shall be repaired and replaced at no cost to the owner. The contractor shall retest the system at their own cost until the manufacturers startup requirements and pre-functional testing criteria are met.

### 3.7 FUNCTIONAL TESTING

- A. After review and acceptance of the manufacturer startup forms and pre-functional checklists, the CxA will schedule dates to begin functional testing.
- B. Functional testing is intended to begin upon completion of a system installation, startup and pre-functional testing. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and Owner. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all PFTs as soon as possible.
- C. Procedure Acceptance
  1. On-Site Conditional Acceptance
  2. Upon satisfactory completion of each commissioning procedure and completion of the procedure close-out meeting, the CxA shall provide conditional acceptance of the procedure.
  3. Conditional acceptance shall indicate that the related installation work checked by the procedure and the related performance verified by the procedure is satisfactory, and that the required procedure has been completed, only.
  4. Conditional acceptance shall not imply that the equipment and systems involved with the procedure are fully approved and have been provided with final acceptance. Conditional acceptance shall additionally be subject to all notes and comments included in the field notes or test forms, and subject to the satisfactory demonstration that all associated pre-testing, special testing, special testing reports, or alignment reports have been fully completed.
  5. Conditional acceptance shall be indicated by the signature of the CxA on the functional testing form.
  6. At the completion of completion of testing, a conditional acceptance memo will be provided to the project team. Conditional acceptance suggests that the majority, if not all, testing has been completed and systems are largely functional and ready to support occupancy. This conditional acceptance memo will be attached to the most current issues log.
- D. On-Site Procedure Rejection
  1. The CxA shall have the authority to reject a procedure in its entirety or to cause the procedure to be stopped if in the opinion of the CxA, any of the following conditions exist:

- a. The pre-procedure review meeting is incomplete.
  - b. Appropriate or sufficient contractor staff is not available or required commissioning representatives are not present.
  - c. Required pre-testing or report data, such as point-to-point control verifications, alignment reports, and trend log data is not available or is incomplete.
  - d. The installation is insufficient or incomplete as required for the procedure or not in compliance with the Contract Documents.
  - e. Numerous checks or tests fail or cannot be accomplished.
  - f. Installation and/or operation of equipment or systems beyond or in advance of the commissioning requirements.
  - g. Installation, operation, or commissioning not in compliance with the sequencing requirements.
  - h. Indication of improper maintenance or operation.
  - i. Inadequate instrumentation
2. The CxA shall additionally reject a procedure and require the equipment operation or procedure to be stopped if in the opinion of the CxA unsafe conditions to either staff or equipment exist. Consideration of safety issues by the CxA shall not in any way relieve the Contractor from his sole responsibility for job site safety and protection of the equipment.
  3. Direction to stop the procedure or halt the operation of equipment will be given verbally. Upon notification the Contractor shall immediately stop the procedure and restore the system or equipment to a safe condition.
  4. At the discretion of the CxA, the Contractor may be afforded the opportunity to correct the conditions indicated by the CxA and resume the procedure.
  5. If in the opinion of the CxA corrections cannot be implemented in a satisfactory manner, within the scheduled time available for the procedure and with sufficient time available to complete the procedure, the procedure shall be stopped and rescheduled by the CxM. The CxA shall provide the CxM with written notification of procedure rejection stating the cause of the action.
  6. The Contractor shall be liable for all actual costs associated with the required attendance by the CxA, the Owner's and A/E's commissioning representatives, and required outside agents, resulting from rejected procedure.

7. Actual costs shall include:
  - a. Cost for the CxA and for each Owner's and A/E's commissioning representative, which are comprised of contractual billing rate as defined in the respective organization's agreement for such work, including overhead and profit. For CxA and A/E's commissioning representatives, these rates may be found in the A/E schedule for additional services.
  - b. Travel-related expenses for the CxA and for each Owner's or A/E's commissioning representative, where such staff is required to be in attendance and not headquartered within the city limits, which are comprised of compensation for actual travel time, with an established minimum of 5 hours, and mileage rates, billed at the prevailing national government rate.
  - c. Costs assessed for required outside agents, contractors, or specialists employed by the Owner or A/E at the actual contractual billing rates as defined in the respective organization's agreement for such work.
  - d. Equipment rentals, special tools, and related material fees associated with the participation of contracted outside organizations and specialists.
8. The costs assessed will be documented by the CxA and will be deducted from the Contractor's fees or progress payments at the time of occurrence.

### 3.8 FINAL ACCEPTANCE

- A. Final acceptance will be contingent upon satisfactory completion of all commissioning tasks and submittals, with final review and approval by the Commissioning Authority.
- B. Where specific components, equipment, or system elements are unable to comply with the specified requirements due to improper or incomplete installation, product defect, or failure of a device to perform to the manufacturer's published or advertised capabilities, final acceptance will be contingent on repair, replacement, and correction of the deficiencies by the Contractor and satisfactory completion of the commissioning procedures.
- C. Where specific components, equipment, or system elements are demonstrated to comply with the specified requirements and perform to the manufacturer's published or advertised capabilities, but are demonstrated not to provide the performance as required by the Contract Documents and the commissioning procedures, disposition of the issue and/or related modifications shall be provided as directed by the Architect. Final acceptance shall be contingent on the completion of any resulting correction work and related commissioning requirements determined as necessary in final disposition of the issue.

- D. Upon satisfactory completion of all commissioning work and resolution of all related issues, the CxA shall provide the Owner, Contractor, and the Architect with a final report documenting recommendation for final acceptance. Recommendation for final acceptance by the CxA shall indicate that in the opinion of the CxA, and as demonstrated within the extent and scope of the commissioning process, the equipment and systems have been installed in compliance with, and function as required by the Contract Documents.
  
- E. The Owner may accept the recommendation of the CxA and provide final acceptance by providing the appropriate authorized signature and by providing copies of the signed acceptance to all parties involved. The Owner's final acceptance of the commissioning work shall indicate that Owner accepts that the systems and equipment, as demonstrated within the extent and scope of the commissioning process, have been installed in compliance with, and function as required by, the Contract Documents. The Owner's acceptance shall not constitute agreement that all contractual obligations are fulfilled and does not constitute final acceptance of the project under the terms and conditions of the Contract Documents.

END OF SECTION

- E. Control Wiring and Interface to Line Voltage Control
  - 1. ATC Contractor shall be responsible for all wiring required for this project regardless of VA requirements.
  
- D. Commissioning: ATC Contractor shall be responsible for self-commissioning of all hardware and software furnished with the project. Completed field commissioning sheets shall be included with the final "as-built" O&M manuals. These sheets shall include validation check fields for all physical and LAN inputs and outputs and graphics for each operating unit or system within the facility. Each system and point shall be listed, using logical names for future reference by the owner. Commissioning shall include calibration and verification of operation of each I/O and graphic field. Functional commissioning of software programming to meet sequences of operation as submitted and approved shall be verified on the field commissioning sheets.
  
- E. Training and Technical Support: Contractor shall provide 8 hours of training to owner representatives on operation and servicing of automatic temperature control system. Training shall be oriented to making the owner self sufficient in the day to day use and operation of the DDC system. Additionally the training shall include information specifically focused on showing the owners representative methods of troubleshooting the mechanical systems using the DDC system. For this purpose, the trainer must be well grounded in both DDC system operation and in mechanical systems service.
  
- F. The contractor shall provide unlimited phone technical support to the owners representative during the one year warranty period. If the technical support location of the contractor is outside of the toll free calling area for the customer, the contractor shall have a toll free number or accept collect calls for the purpose of providing technical support.

### 1.3 SUBMITTALS AND O&M MANUALS

- A. Submittals
  - 1. Submittals shall include the following sections:
  - 2. Shop Drawings with:
    - a. Title Page
    - b. Table of Contents
    - c. Typical Device Wiring Drawings
    - d. Summary Bill of Materials
    - e. Local Area Network Drawings
    - f. Drawings for all operating systems showing both equipment and module connections  
(Note: drawings for individual operating systems shall include individual Bills of Materials)
  
- B. Sequences of Operation
  - 1. Manufacturers specification data sheets for all control modules, sensors, dampers, valves, actuators, flow switches, current sensors and transducers required in the project.



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

C. O&M Manuals

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

1.4 SYSTEM SOFTWARE

A. System Software

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

**PART 2 - CONTRACTOR CAPABILITY**

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

**PART 3 - PRODUCT CAPABILITY - HARDWARE**

3.1 SYSTEM SERVER

- A. Software shall be installed on owner's existing WebCTRL server.

3.2 FIELD HARDWARE

A. BACnet Compatibility

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

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

- C. Distributed Control: System shall observe the concept of distributed control. All modules shall have "stand alone" capability and shall maintain operator setpoints without connection to primary controllers or central station equipment. Modules shall be located at each operating equipment location such that individual systems or zones shall remain

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

- D. Ethernet Gateway Routers: System shall include an Ethernet Router/Gateway between the control module network and owners Ethernet. This gateway shall route BACnet communications between the control module network and the owners IP network. If the system is not to be connected to customer Ethernet the gateway shall be capable of connection via a web browser on the local host server.
- E. Valve and Damper Actuators: Actuators shall be manufactured by Belimo. Torque shall be rated for required load. Modulated actuator input shall be industry standard 0-10 vdc, 2-10 vdc, 4-20 milli-amp, floating motor (tri-state), or pulse width modulation. Two or three position operation is not acceptable for economizers, VAV dampers, multizone dampers, valves or any other application specifying modulated operation.
- F. Dampers: Outside air control dampers shall have neoprene or vinyl-grip blade seals, stainless spring steel edge seals and a specified leakage rate of not more than 65 CFM/damper face area at 2" W.G. static pressure drop.
- G. Wire: All wiring in open areas at heights below 12 feet must be run in conduit, otherwise control wiring may be run open in accessible ceiling or underfloor areas. Control wiring in non-accessible ceilings, walls or floors shall be in conduit. All wiring not in conduit or control cabinets shall be rated for plenum installation. Communication wiring shall be run in data cable tray whenever possible.

## **PART 4 - PRODUCT CAPABILITY - SOFTWARE**

### **4.1. BACnet COMPATIBILITY**

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


Binary Output	Writeproperty
Binary Value	I-Am
Analog Input	I-Have
Analog Output	ReadMultiple Property
Analog Value	WriteMultiple Property
Calendar	Who-Has
Schedules	Who-Is
- C Programming for the system shall use BACnet objects and services. All BACnet objects and services shall be opened for read and/or read/write access during programming for future exposure to other BACnet systems. The front end software for the system shall be able to query other third party BACnet points for read/write access.

### **4.2 MULTIPLE OPERATING PLATFORMS**

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

#### 4.3. GRAPHICAL PROGRAMMING

- A. The system shall be programmed using Eikon™ graphical programming language for ease of operator understanding. Operating sequences and logic flow shall be assembled in a schematic format using MicroBlocks representing inputs, outputs and logical functions such as setpoints, switches, limits, relays, PIDs etc. The programming software shall be furnished within this scope of work.
- B. Full simulation capability shall also be provided with the graphic programming. User shall be able to fully simulate the constructed sequence on screen before the sequences are downloaded into the controllers. The system shall also include the ability to simulate multiple graphic programs communicating with each other on a simulated network.

#### 4.4. GRAPHICAL INTERFACE SOFTWARE

- A. System and Equipment Graphic User Interface: The operators interface software shall be developed using ViewBuilder™ graphical development software. Graphics display screens shall include a system level graphic of either a map of facilities or an elevation of the building, a graphic of each building floor plan and graphics for each operating system or unit within each building. Entry to the zone and equipment level interface graphics shall be through area maps and/or floor plans to facilitate user orientation. Additionally the system hierarchy shall be displayed in a fashion similar to Windows Explorer to enable the user to navigate to any graphical screen in the system by expanding building levels or floor levels and selecting a particular zone or system. Graphics shall be accessed by using a mouse or other pointer device. The system shall provide a visual indication of which building, floor and zone the user is accessing at any time. System shall be capable of changing all parameters and schedules, as well as downloading operating software from the same Graphical User Interface software program as that used for viewing system operation.
- B. Thermal graphic floor plans shall display each temperature zone in a color appropriate to current space temperature conditions. The system shall display in 8 separate colors the following conditions: High or low temperature alarm, temperature at setpoint, cooling call, heating call, more than 2° above setpoint, more than 2° below setpoint, unoccupied between setpoints and no communication. Floor plans shall also include color graphic indicators for non-zone specific mechanical equipment operation showing On/Off and Alarm Conditions. Status indication colors shall be updated dynamically as conditions change.
- C. Mechanical equipment pictorial graphics shall be displayed by the use of point-and-shoot selection using a mouse or other pointer device. Graphics shall be provided for all mechanical equipment and devices controlled by the DDC system. These graphics shall provide a current status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate engineering units at appropriate locations on the graphic representation.

#### 4.5 FACILITY MANAGEMENT AND ENERGY MANAGEMENT FUNCTIONS

##### TEMPERATURE CONTROLS

- A. Scheduling: The DDC system shall have the ability to schedule each individual zone, each building or floor or the entire network of buildings for any user with a single entry. Additionally the operator shall have the capability of assembling groups of zones, buildings or floors for single entry programming, e.g. several offices may be grouped for scheduling of Saturday operations. Available schedule types shall include normal operation, unoccupied operation, setback override and holidays. For maximum flexibility, schedules shall reside in the local control modules. Dated schedules shall be self managing and automatically delete after execution.
- B. Interactive Operations: The system shall have the ability to send run requests, heating requests and cooling requests from one module to another for the purpose of optimizing run operations of central plant equipment. Additionally the system shall be capable of limiting operation of various equipment if another mechanical point elsewhere in the system allows that operation. e.g. a boiler loop circulating pump shall run only when requested by a zone requiring heating operation and will shut down during hours that zone demand is satisfied.

#### 4.6. ALARMS, TRENDS AND REPORTS

- A. System and Temperature Alarms: The system shall have the capability of monitoring conditions throughout the system and sending alarms or messages to an e-mail address, local PC or printer or to remote PC's, printers or to dial-up pagers. Alarms and messages shall be able to be prioritized for various levels of reporting and action. The operator shall have the ability to customize alarm text and messages.
- B. Trends: The system shall be capable of trending any input or output, or any logical point within the graphic program. There shall be no limitation to the number of points that can be trended at any particular time. Modules shall store in live memory 288 trend samples points for each trended item. The interval between trend samples shall be adjustable from 1 second to 24 hours. Trends from one or more modules shall be able to be simultaneously displayed on a single trend graph. Operator shall be able to "window" any segment of a trend to enlarge the view by dragging a mouse to form the "window". The system shall also have the ability of automatically downloading trend information from any module to the server or other computer connected to the network for historical trend storage. This trend information shall be able to be displayed on the trend graph along with live current trends in seamless fashion. Trend data collection requiring the use of a locally connected PC for data storage is unacceptable.
- C. Reports: The system shall be capable of generating reports of equipment run times, all trended points, temperature conditions, electric demand and usage and alarms or messages. The system shall also have the ability of automatically downloading report information from any module to the server or other computer connected to the network. The operator shall have the ability to create custom report and logging formats.

## PART 5 - SEQUENCES OF OPERATION

### 5.1. GENERAL

- A. 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. Adjustable Parameters
  - 1. All numeric values in the Sequence of Operation are adjustable parameters that can be modified without program changes or re-downloading that would interrupt system operation.
  
- C. Power Loss to Control Modules
  - 1. All control modules are equipped with battery backup and will retain programming, including time of day, upon loss of power. On return of power control functions will return to normal operation based on scheduling and time of day with no operator interface. Delay on start parameters can be setup at random intervals to prevent demand surges on restart.
  
- D. Power Loss to Server
  - 1. On loss of power to the server only the EMCS will continue to run as normal. The EMCS human interface software, WebCTRL, is a network service and will automatically restart and connect to the system when power is restored.
  
- D. Trends
  - 1. Trending is available, by default, on any BACnet I/O point. Trends can also be added for any digital or analog value in the program.
  - 2. Trending will be setup for all significant I/O points.
    - a. Analog values will be set to log every 5 minutes and store 288 data points for live retrieval.
    - b. Binary points will be set to trend on Change of Value (COV) and to store 100 COV trend samples live.
    - c. Sample frequency and quantity of stored data are adjustable within the memory limits of each module. e.g.
    - d. Trends can set to be logged every 5 minutes with 288 trend points allocated so that the live display will show 24 hours of trend data.
  - 3. Extended trending is available by archiving trends using Trend Historian for server storage.
  
- E. Schedules
  - 1. Schedules can be set for all systems in a customer database, or for a single building, a single floor, or for an individual zone.
  
  - 2. Additionally, groups of equipment can be assembled in Schedule Groups for single entry scheduling of multiple zones for specific functions.
    - a. For example a Gym Activities Group could be used for single entry scheduling for practices, ball games etc.
    - b. Another example would be a group of rooms occupied by a single tenant who has frequent need for space conditioning during otherwise unoccupied times.
  
  - 3. Schedules can be set for weekly reoccurring occupancy, dated weekly, date, date range, wildcard or continuous and can be set for multiple years in advance.

4. Occupancy schedules will initiate from the zone level.
    - a. Air handling units, chillers, boilers, pumps etc. whose operation is intended to provide air or water flow to zones will function based on Run Requests, Cooling Requests or Heating Requests from the zones they serve. These central systems will not have separate scheduling capability.
  - F. Optimal Start:
    1. The microblock will use an optimal start algorithm to adjust the zone setpoint before the zone is occupied, ensuring that the zone temperature is within the occupied setpoints by the time the zone is occupied.
  - G. Learning Adaptive:
    1. Adjusts (learns) zone heating and cooling capacities based on optimal start system performance.
    2. Learning will be disabled automatically after the first 12 months of operation. (Adjustable)
  - H. Outside Air Conditions
    1. Outside air temperature will be monitored.
    2. Outside air conditions can be mapped to any controller for use for local control sequencing.
  - I. Alarming
    1. All alarms generated by WebCTRL may be setup for the following actions:
      - a. Alarm Popup
      - b. Send E-Mail
      - c. Write to File
      - d. Send as Text
    2. All alarms may be enabled or disabled by the operator without program change or memory download.
- 5.2
- 5.5. DISTRIBUTED CONTROL
- A. 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.
- 5.6 Central Plant, Pump and Fan Operation: Control of all central fan systems, chillers, boilers and pumping stations shall be based on run requests, heating requests or cooling requests from zone controls. Reset of supply air static pressure, supply air temperature, chilled water temperature and hot water temperature shall be based on zone temperature conditions and heating or cooling requests from zones.
- 5.7. Scheduling: For maximum flexibility all occupancy schedules shall be stored in zone control modules. Central fans or pumps shall start when commanded from any associated zones that call for occupancy or for operation to meet setback heating or cooling requirements and shall not require separate scheduling unless required for the sequence of operation. Fans or pumps shall run for minimum of 30 minutes.

DPW PROJECT NO. 19240  
Alumni and Visitor's Center  
Idaho State University  
Pocatello, Idaho

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END OF SECTION

## **SECTION 23 21 66**

### **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](http://www.carrier-commercial.com)
- b. Friedrich Air Conditioning Co, Austin, TX (800) 541-6645 or (210) 225-2000 [www.friedrich.com](http://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](http://www.sanyo.com)
- e. L.G. Electronics, USA, Englewood Cliffs, NJ (201) 585-0018, [www.lghvac.com](http://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

## **SECTION 23 23 00**

### **REFRIGERANT PIPING 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 and install piping for refrigeration systems as described in Contract Documents.

##### 1.3 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Refrigerant piping shall be installed by a refrigeration contractor licensed by State.

#### **PART 2 - PRODUCTS**

##### 2.1 REFRIGERANT PIPING

- A. Meet requirements of ASTM B 280-88, "Specification for Seamless Copper Tube for Air Conditioning & Refrigeration Field Service", hard drawn straight lengths.
- B. Do not use pre-charged refrigerant lines.

##### 2.2 REFRIGERANT FITTINGS

- A. Wrought copper with long radius elbows.
- B. Approved Manufacturers:
  - 1. Mueller Streamline
  - 2. Nibco Inc
  - 3. Grinnell
  - 4. Elkhart Products Corp

##### 2.3 CONNECTION MATERIAL

- A. Brazing Rods:
  - 1. Copper to Copper Connections:
  - 2. AWS Classification BCuP-4 Copper Phosphorus (6% silver).
  - 3. AWS Classification BCuP-5 Copper Phosphorus (15% silver).
  - 4. Copper to Brass or Copper to Steel Connections:
  - 5. AWS Classification BAg-5 Silver (45% silver).
  - 6. Do not use rods containing Cadmium.

## 2.4 FLUX

- A. Approved Manufacturers:
  - 1. "Stay-Silv white brazing flux" by J W Harris Co
  - 2. High quality silver solder flux by Handy & Harmon

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Do not install refrigerant piping underground or in tunnels.
- B. Slope suction lines down toward compressor one inch/10 feet. Locate traps at vertical rises against flow in suction lines.
- C. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary.
  - 1. No soft solder (tin, lead, antimony) connections will be allowed in system.
- D. Braze valve, sight glass, and flexible connections.
- E. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

### 3.2 FIELD QUALITY CONTROL

- A. Make evacuation and leak tests in presence of Architect's Engineer after completing refrigeration piping systems. Positive pressure test will not suffice for procedure outlined below.
  - 1. Draw vacuum on each entire system with vacuum pump to 200 microns using vacuum gauge calibrated in microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum. Isolate compressor from system piping using shut-off valves prior to pulling vacuum.
  - 2. Break vacuum with freon to be used and re-establish vacuum test. Vacuum shall hold for 24 hours at 200 microns without compressor running.
  - 3. Conduct tests at 70 deg F ambient temperature minimum.
  - 4. Do not run systems until above tests have been made and systems started up as specified. Inform Owner's Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.
  - 5. After testing, fully charge system with refrigerant and conduct test with Halide Leak Detector.

END OF SECTION

## **SECTION 23 23 10**

### **REFRIGERANT SPECIALTIES**

#### **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 refrigeration specialties as described in Contract Documents except for expansion valves on 2 through 5 ton condensing units.

#### **PART 2 - PRODUCTS**

##### 2.1 EXPANSION VALVES

- A. For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.
- B. Size valves to provide full rated capacity of cooling coil served. Coordinate selection with evaporator coil and condensing unit.
- C. Approved Manufacturers:
  - 1. Alco
  - 2. Henry
  - 3. Mueller
  - 4. Parker
  - 5. Singer
  - 6. Sporlan

##### 2.2 FILTER-DRIER

- A. On lines 3/4 inch outside diameter and larger, filter-drier shall be replaceable core type with Schraeder type valve.
- B. On lines smaller than 3/4 inch outside diameter, filter-drier shall be sealed type using flared copper fittings.
- C. Size shall be full line size.
- D. Approved Manufacturers:
  - 1. Alco
  - 2. Mueller
  - 3. Parker
  - 4. Sporlan
  - 5. Virginia

## 2.3 SIGHT GLASS

- A. Combination moisture and liquid indicator with protection cap.
- B. Sight glass shall be full line size.
- C. Sight glass connections shall be solid copper or brass, no copper-coated steel sight glasses allowed.
- D. Approved Manufacturers:
  - 1. Alco
  - 2. Mueller
  - 3. Parker
  - 4. Superior
  - 5. Virginia

## 2.4 MANUAL REFRIGERANT SHUT-OFF VALVE

- A. Ball valves designed for refrigeration service and full line size.
- B. Valve shall have cap seals.
- C. Valves with hand wheels are not acceptable.
- D. Provide service valve on each liquid and suction line at compressor.
- E. If service valves come as integral part of condensing unit, additional service valves shall not be required.
- F. Approved Manufacturers:
  - 1. ConBraCo (Apollo)
  - 2. Henry
  - 3. Mueller
  - 4. Superior
  - 5. Virginia

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install valves and specialties in accessible locations. Install refrigeration distributors and suction outlet at same end of coil.

END OF SECTION

## **SECTION 23 31 14**

### **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

## **SECTION 23 33 46**

### **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

## **SECTION 23 34 00**

### **EXHAUST FANS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Furnish and install exhaust fans as described in Contract Documents.

##### 1.3 QUALITY ASSURANCES

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

#### **PART 2 - PRODUCTS**

##### 2.1 CEILING MOUNTED EXHAUST FANS

- A. Acoustically insulated housings.
- B. Sound level rating of 4.6 sones maximum for fan RPM and CFM listed on Drawings.
- C. Include chatterproof integral back-draft damper with no metal to metal contact.
- D. True centrifugal wheels.
- E. Entire fan, motor, and wheel assembly shall be easily removable without disturbing housing.
- F. Suitably ground motors and mount on rubber-in shear vibration isolators.
- G. Provide wall or roof cap, as required.
- H. Approved Manufacturers:
  - 1. Cook-Gemini
  - 2. Greenheck Sp
  - 3. Pace
  - 4. Penn Zephyr

##### 2.2 ROOF MOUNTED EXHAUST FANS

- A. Direct drive or have adjustable pitch V-belt as noted on Drawings.
- B. Wheels shall be backward curved and housing shall be removable or hinged

aluminum.

- C. Isolate motor with vibration dampeners.
- D. Provide quiet type back-draft dampers.
- E. Insulated, pre-fabricated metal roof curb shall be for flat or sloped roof as shown on Drawings.
- F. Approved Manufacturers:
  - 1. Fans:
    - a. Penn
    - b. Centri-Master
    - c. Cook
    - d. Greenheck G, GB
  - 2. Standard curbs:
    - a. Penn
    - b. Cook
    - c. Greenheck
  - 3. Sound attenuating curbs:
    - a. Penn
    - b. Greenheck

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

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

END OF SECTION

## **SECTION 23 37 13**

### **AIR OUTLETS & INLETS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

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

#### **PART 2 - PRODUCTS**

##### 2.1 GRILLES & REGISTERS

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

##### 2.2 SPIN-IN FITTINGS

- A. Low pressure round take-offs to diffusers shall be made with spin-in fittings. They shall incorporate a manual balancing damper. The damper shall be spring loaded and a positive locking wing nut shall secure the damper position.
- B. Approved Manufacturers:
  - 1. Sheet metal fittings: Genflex DB-1DEL, Hercules

##### 2.3 LOUVERS

- A. Extruded aluminum, with blades welded or screwed into frames and 1/2 inch mesh 16 gauge aluminum bird screen.
- B. Frames shall have mitered corners.
- C. Louvers shall be recessed, flanged, stationary, or removable as noted on Drawings.
- D. Approved Manufacturers:
  - 1. Airolite
  - 2. American Warming
  - 3. Arrow
  - 4. Industrial Louvers

5. Ruskin
6. Vent Products

### **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**



## **SECTION 23 38 13**

### **KITCHEN HOOD**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 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

## **SECTION 23 38 15**

### **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 0100 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

## **SECTION 23 41 00**

### **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 FURNACE FILTERS

- A. Filters shall be one inch thick throw-away type as recommended by Furnace Manufacturer.

##### 2.2 ROOF TOP UNIT FILTERS

- A. 2 inch thick, medium efficiency, disposable type pre-formed pleated design, having at least 4.5 sq ft of filtering media per sq ft of face area.
- B. Media shall be reinforced non-woven cotton fabric, treated with adhesive similar to "Vyclad B" and continuously laminated to supporting steel wire grid conforming to configuration of pleats.
- C. Media pack shall be sealed in a chipboard frame or beverage board.
- D. Filters shall have rated average efficiency of 25 to 30% on ASHRAE Test Standard 52-76 and be capable of operating with variable face velocities up to 500 FPM without impairing efficiency.
- E. Initial resistance shall not exceed 0.30 inches w.g. at 500 FPM or 0.14 inch w.g. at 300 FPM. Filter shall be listed Class 2 by UL.
- F. Approved Manufacturers:
  - 1. Type 30/30 by Farr Co
  - 2. Mark 80 by Serv-Aire
  - 3. HC Type 40 by Envopleat
  - 4. DP2-40 by Air Guard

END OF SECTION

## **SECTION 23 54 17**

### **HIGH EFFICIENCY NATURAL GAS FURNACE**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Furnish and install gas fired condensing high efficiency furnace as described in Contract Documents.

#### **PART 2 - PRODUCTS**

##### 2.1 MANUFACTURED UNITS

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

5. 2" or 3" intake and exhaust lines to outside with factory furnished combination flue/intake assembly for roof or sidewall.

C. Approved Manufacturers:

1. Lennox
2. Carrier
3. York
4. Trane

### **PART 3 - EXECUTION**

#### **3.1 FIELD QUALITY CONTROL**

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

END OF SECTION



## **SECTION 23 55 40**

### **ELECTRIC RADIANT WALL HEATERS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

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

##### 1.3 QUALITY ASSURANCE

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

#### **PART 2 - PRODUCTS**

##### 2.1 MANUFACTURED UNITS

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

END OF SECTION

## **SECTION 23 62 13**

### **AIR-COOLED CONDENSING UNITS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Furnish and install condensing units as described in Contract Documents.

##### 1.3 WARRANTY

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

#### **PART 2 - PRODUCTS**

##### 2.1 TWO TON THROUGH FIVE TON UNITS

- A. Condenser coil shall have aluminum plate fins mechanically bonded to seamless copper tubes.
  - 1. Provide coil guard for unit.
- B. Fans shall be direct driven propeller upflow type.
  - 1. Fan motor shall be single or two speed, thermostatically controlled, permanently lubricated, and designed with permanent protection and ball bearings.
  - 2. Motors shall be resiliently mounted.
  - 3. Each fan shall have a safety guard.
- C. Units shall be operable down to 0 deg F outdoor temperature.
- D. Compressor shall be of hermetic design with the following features. Each condenser unit shall have only one compressor.
  - 1. Externally mounted brass service valves with charging connections.
  - 2. Crankcase heater.
  - 3. Resilient rubber mounts.
  - 4. Compressor motor overload protection.
  - 5. Single speed
- E. Controls:
  - 1. Factory wired and located in separate enclosure.
  - 2. Safety devices shall consist of high and low pressure cutout and condenser fan motor overload devices.
  - 3. Unit shall have anti-cycle timers to prevent units from starting up again for five minutes after any power interruption.

- F. Casing:
  - 1. Fully weatherproof for outdoor installation. Finish shall be weather resistant.
  - 2. Openings shall be provided for power and refrigerant connections.
  - 3. Panels shall be removable for servicing.
  
- G. Expansion Valves:
  - 1. Stainless steel diaphragm and same refrigerant in thermostatic elements as in system. Externally or internally equalized as required by evaporator/condensing system.
  - 2. Size valves to provide full rated capacity of cooling coil served.
  - 3. Furnished by evaporator coil/condensing unit supplier and coordinated to provide bleed holes for system pressure equalization, if required.
  
- H. Condensing units shall use R-410A refrigerant. Only one liquid line, one suction line, and one power connection shall be made to each compressor. Provide charging valves.
  
- I. SEER rating as defined by ARI shall be not less than 13.0.
  
- J. Approved Manufacturers:
  - 1. York
  - 2. Carrier
  - 3. Lennox
  - 4. Trane

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

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

#### **3.2 FIELD QUALITY CONTROL**

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

**END OF SECTION**

## **SECTION 23 62 20**

### **ROOFTOP HEATING-COOLING UNIT**

#### **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 QUALITY ASSURANCE

- A. Unit shall be AGA certified.

##### 1.3 WARRANTY

- A. Provide five-year warranty on compressors.

#### **PART 2 - PRODUCTS**

##### 2.1 MANUFACTURED UNITS

- A. Unit shall be one piece combination air-to-air DX mechanical cooling system and propane gas fired heating system complete with automatic controls.
- B. Equipment shall be shipped completely assembled, pre-charged, piped and wired internally ready for field connections.
- C. Roof mounting frame shall be furnished and installed. Frame shall be steel and mate to bottom perimeter of equipment. When flashed into roof, it shall make a unit mounting curb and provide weather-proof duct connection and entry into conditioning area.
- D. Power Saver: (Fresh Air Dampers)
  - 1. Provide complete with all controls and air mixing damper assembly, including fresh air, recirculated air, and exhaust air dampers.
  - 2. Fresh air section shall be equipped with air filters.
  - 3. Mixing box sections shall contain low leakage dampers with edge seals and inflatable blade seals.
- E. Cooling System:
  - 1. Coils shall be non-ferrous construction with aluminum fins mechanically bonded to seamless copper tubes.
  - 2. Condenser coil shall have sub-cooling rows.
  - 3. Compressor shall be resiliently mounted, have built-in 3-mode crankshaft lubrication, crankcase heater, discharge temperature limiter, current and temperature sensing motor overloads.
  - 4. Cooling system shall be protected by high and low pressure switches and compressor timed off control.
  - 5. Provide with hail guard over condenser coil.

- F. Heating System:
  - 1. Automatic controls furnished to give 50/50 2-stage operation.
  - 2. Cylindrical tube and drum exchanger constructed of Duraglas coated steel or stainless steel.
  - 3. Stainless steel burner listed for operation at low outdoor air temperatures.
  - 4. Visual inspection of burner flame possible through observation port at rear of heat exchanger.
  - 5. Power vented.
  
- G. Air Movers:
  - 1. Twin centrifugal conditioned air blowers with permanently lubricated ball bearings, adjustable belt drive or direct drive as shown on drawings.
  - 2. Condenser fans shall be direct driven.
  - 3. Motors shall have inherent protection devices.
  
- H. Frame and Casing:
  - 1. Frame shall be welded construction.
  - 2. Casing shall be galvanized panels with baked-on outdoor enamel finish.
  - 3. Entire cabinet shall be insulated with 1" thick fiberglass.
  - 4. Provide coil guards on exposed condenser coils.
  
- I. Furnish two sets of 2" throw away filters.
  
- J. Provide with 7-day web enabled programmable thermostat equal to Honeywell "Prestige". Provide with remote sensors where shown on drawings.
  
- K. Approved Manufacturers:
  - 1. Lennox
  - 2. Trane
  - 3. Carrier

### **PART 3 - EXECUTION**

#### **3.1 FIELD QUALITY CONTROL**

- A. Provide manufacturer's startup and warranty.

END OF SECTION

END OF DIVISION