

## ADDENDUM NO. 2 – RESPONSES TO BID RFI'S

Date: 6/14/2023

Project Title: Howard County Public Schools – Cafeteria HVAC Unit Conversions

HCPSS Bid #123.23.B3

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### **BID RFI'S AND RESPONSES**

**QUESTION:** Is the contractor to replace air filters before air balancing is performed? If so, please provide filter size and quantity.

**RESPONSE:** Air filters are to be replaced before air balancing is performed. HCPSS will furnish the air filters to the contractor.

**QUESTION:** Roofing specs 075113 and 075419 are missing from the documents

**RESPONSE:** Specifications are included in the Addendum No. 2 document package.

**QUESTION:** What roofing company carries the warranties for the applicable roofs

**RESPONSE:** The roofs with schools receiving relief air hoods (Glenelg HS and Oakland Mills HS) are under warranty. Glenelg HS: GAF built-up roof; Oakland Mills HS: Sarnafil PVC roof. Tecta America shall perform all roofing work. Contact: Chris Sargent (443) 506-4691.

**QUESTION:** Is VFD cable required from the new VFD's to the new motors.

**RESPONSE:** Type TC-ER shielded cable is required from the VFDs to the new motors.

**QUESTION:** Some of the schools have sprinkler lines in the way of installing the coils - will HCPSS be responsible for removing and re-installing the sprinkler lines in those areas? If not, please provide current sprinkler company per location.

**RESPONSE:** Contractor is responsible for removal/reinstallation/relocation of sprinkler piping if it is a conflict in order to install the duct heating coils. Contractor shall call Emergency24 (third party contractor) to place the building fire alarm system "Out of Service." The contractor shall perform all necessary sprinkler work, including draining and refilling the sprinkler system and performing a fire watch as long as the sprinkler system is out of service and the building is occupied. Upon completion of sprinkler work, the contractor shall place the fire alarm system back into service through the Emergency24 contractor.

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**QUESTION:** Duct cleaning - page 282- section 3.12g states that 20' of ductwork needs to be cleaned before and after the coils, but section 3.14 says to clean the entire system - please advise which is required.

**RESPONSE:** Only 20 feet of ductwork is required to be cleaned before and after the coils. Specification has been updated to reflect this change in 230500. Updated specification is included in the Addendum No. 2 package.

**QUESTION:** Demonstration and video recording at each location - is this required for this project? If so, is written narration also required?

**RESPONSE:** A demonstration and video recording of pertinent portions of the demonstration is required at each location. Verbal narration during the videotaping is acceptable.

**QUESTION:** Duct testing - page 350 references duct testing - is this a requirement of this project?

**RESPONSE:** Duct leakage testing is not required. Specification has been updated to reflect this change in 233113. Updated specification is included in the Addendum No. 2 package.

**QUESTION:** The motors listed on drawing M801 show some of the motors as 2-phase 480v. Please confirm that all motors shall be 480v 3-phase.

**RESPONSE:** Motors are all 480v 3-phase. Drawing M801 has been updated to reflect this change. Updated drawing is included in the Addendum No. 2 package.

**DRAWING CHANGES**

**M701**

- Refer to revisions indicated on M701.
  - Heating coil control valve revised to 2-way valve.

**M707**

- Refer to revisions indicated on M707.
  - Heating coil control valves revised to 2-way valves.

**M801**

- Refer to revisions indicated on M801.
  - Fan Motor schedule updated to indicate 480v 3-phase for all motors.
  - Fan Motor schedule updated to reflect 7-1/2 HP motor for GHS-SF-2 verified during bid site visit.
  - Variable Frequency Drives schedule updated to reflect 7-1/2 HP motor for VFD-GHS-SF-2.

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**E103**

- Refer to revisions indicated on E103.
  - Mechanical Equipment Electrical Connection schedule updated to reflect 7-1/2 HP motor for GHS-SF-2 verified during bid site visit.

**SPECIFICATION CHANGES**

**SPECIFICATION SECTION 075113**

- Specification section included in Addendum No. 2 document updates.

**SPECIFICATION SECTION 075419**

- Specification section included in Addendum No. 2 document updates.

**SPECIFICATION SECTION 055000**

- Specification section included in Addendum No. 2 document updates.

**SPECIFICATION SECTION 230500**

- Refer to revisions indicated within 230500.
  - Specification updated to clarify only 20 feet of ductwork is required to be cleaned before and after the coils.

**SPECIFICATION SECTION 233113**

- Refer to revisions indicated within 233113.
  - Specification updated to remove duct leakage testing.

## SECTION 055000 - METAL FABRICATIONS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Miscellaneous steel framing and supports for roof penetrations.
- B. Products furnished, but not installed, under this Section include the following:
  - 1. Loose steel framing and steel weld plates.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Miscellaneous steel framing.
  - 2. Paint products.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

## PART 2 - PRODUCTS

## 2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

## 2.2 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

## 2.3 MISCELLANEOUS MATERIALS

- A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

#### 2.4 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
- C. Weld corners and seams continuously to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended.
- D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

#### 2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

#### 2.6 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.

#### 2.7 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
  - 1. Shop prime with universal shop primer unless indicated.
- C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning " and below:
  - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  4. Other Items: SSPC-SP 3, "Power Tool Cleaning."
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

**PART 3 - EXECUTION****3.1 INSTALLATION, GENERAL**

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- G. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

SECTION 075113 - BUILT-UP ASPHALT ROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes built-up asphalt roofing (4-Ply) for patching existing roof system at Glenelg High School.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.
- C. Sample warranty.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- B. Source Limitations: Obtain components for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.

1.5 WARRANTY

- A. Special Warranty: Roof work must maintain existing manufacturer's standard warranty, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing that fail in materials or workmanship within specified warranty period.
  - 1. Existing Warranty: Owner to provide.
  - 2. Warranty shall cover damage to building components resulting from leaks, wet or damaged insulation or damage from wind gusts less than 55 mph. and shall include the total roofing system, including insulation, fasteners, flashings, metal flashing and all associated roof system components.

**PART 2 - PRODUCTS**

**2.1 BUILT-UP ROOFING MANUFACTURER**

- A. Manufacturer: Provide the following to comply with the existing roof system/warranty:
  - 1. GAF (verify with Owner).
  - 2. HCPSS-Approved Roofing Contractors:
    - a. Tecta America: Chris Sargent (443) 506-4691
    - b. Cole Roofing: Matt Reinhard (443) 763-2158

**2.2 ACCESSORY ROOFING MATERIALS**

- A. Accessory materials, including base flashing, recommended and required by roofing system manufacturer for intended use and compatible with other roofing components.

**2.3 SUBSTRATE BOARD**

- A. As required to match existing conditions, materials, and existing roofing system and compatible with existing roofing warranty.

**2.4 ROOF INSULATION**

- A. As required to match existing conditions, materials, and existing roofing system and compatible with existing roofing warranty.

**2.5 INSULATION ACCESSORIES AND COVER BOARD**

- A. As required to match existing conditions, materials, and existing roofing system and compatible with existing roofing warranty.

**PART 3 - EXECUTION**

**3.1 INSULATION INSTALLATION**

- A. Patch roofing insulation as required to match existing and to comply with built-up roofing manufacturer's written instructions for installing roof insulation.

**3.2 BUILT-UP ROOFING INSTALLATION**

- A. Install and patch built-up roofing as required to match existing and to comply with manufacturer's written instructions to maintain existing warranty.



**3.3 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
- C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

**3.4 TEMPORARY PROTECTION**

- A. Provide temporary waterstops at the conclusion of each day's work adequate to prevent moisture intrusion into newly installed work and incomplete flashing locations. Remove temporary stops before resuming work.

END OF SECTION 075113

SECTION 075419 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes PVC roofing for patching existing roof system at Oakland Mills High School.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Field quality-control reports.
- C. Sample warranty.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- B. Source Limitations: Obtain components for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.

1.5 WARRANTY

When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

- A. Special Warranty: Roof work must maintain existing manufacturer's standard warranty, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing that fail in materials or workmanship within specified warranty period.
  - 1. Existing Warranty: Owner to provide.
  - 2. Warranty shall cover damage to building components resulting from leaks, wet or damaged insulation or damage from wind gusts less than 55 mph. and shall include the total roofing system, including insulation, fasteners, flashings, metal flashing and all associated roof system components.

**PART 2 - PRODUCTS**

**2.1 POLYVINYL CHLORIDE (PVC) ROOFING MANUFACTURER**

- A. Manufacturer: Provide the following to comply with the existing roof system/warranty:
  - 1. Sarnafil (verify with Owner).

**2.2 ACCESSORY ROOFING MATERIALS**

- A. General: Accessory materials, including base flashing, recommended and required by roofing system manufacturer for intended use and compatible with other roofing components.

**2.3 SUBSTRATE BOARD**

- A. As required to match existing conditions and existing roofing system and compatible with existing roofing warranty.

**2.4 ROOF INSULATION**

- A. As required to match existing conditions and existing roofing system and compatible with existing roofing warranty.

**2.5 INSULATION ACCESSORIES AND COVER BOARD**

- A. As required to match existing conditions, materials, and existing roofing system and compatible with existing roofing warranty.

**PART 3 - EXECUTION**

**3.1 INSULATION INSTALLATION**

- A. Patch roofing insulation as required to match existing and to comply with PVC roofing manufacturer's written instructions for installing roof insulation.

**3.2 PVC ROOFING INSTALLATION**

- A. Install and patch PVC roofing as required to match existing and to comply with manufacturer's written instructions to maintain existing warranty.

**3.3 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.

- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
- C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

**3.4 TEMPORARY PROTECTION**

- A. Provide temporary waterstops at the conclusion of each day's work adequate to prevent moisture intrusion into newly installed work and incomplete flashing locations. Remove temporary stops before resuming work.

END OF SECTION 075419

SECTION 230500 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Requirements of this Section are applicable to work in Division 23.
- B. Contract Documents
  - 1. Unless otherwise modified, drawings and general provisions of the Contract, including provisions of General Conditions, Supplementary Conditions, Division 00, and Division 01 govern work under Division 23.
  - 2. Contract drawings for mechanical work are diagrammatic, intended to convey scope and general arrangement.
  - 3. Refer questions involving document interpretation or discrepancies to Contracting Officer Representative (COR) for review and direction.
  - 4. Correct faulty work due to resolving discrepancies without proper approval.
  - 5. Specifications establish quality of materials, equipment, workmanship and methods of construction.
  - 6. Follow drawings and specifications in laying out work. Consult other applicable contract drawings and specifications, become familiar with conditions affecting work.
- C. Scope
  - 1. The work in Division 23 includes furnishing and installing the mechanical work complete and ready for satisfactory service.
  - 2. Requirements specified govern work in all sections of Division 23.
  - 3. Some of the work described in this section is also applicable to the scope of Division 26.

1.2 RELATED DIVISIONS

- A. Division 01 – General Requirements
- B. Division 02 – Existing Conditions
- C. Division 26 – Electrical

1.3 QUALITY ASSURANCE

- A. Regulations: Comply with regulations of NFPA, Maryland, Howard County, and municipal building ordinances, and other applicable codes and regulations.
- B. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by the local authority as equivalent in safety to UL labeled equipment.
- C. Material and Equipment Requirements
  - 1. Use products of one manufacturer where two or more items of same kind of equipment are required.
  - 2. Materials and equipment shall have a record of one-year successful field use.

3. For certain items of equipment, the specification and the project design are based upon the specified manufacturer's product. Other manufacturers' names are listed. Contractor may purchase, conditional upon meeting project requirements, equipment from the listed manufacturers.
  4. Only the manufacturer's equipment upon which, the specification and the project design has been based, has been checked for this project. Check allocated space and structure for suitability of equipment of other listed manufacturers, including parts replacement and servicing.
  5. Basis of Design Products: Where the Specifications or Drawings name a specific manufacturer's product accompanied by the words "Basis of Design," including make or model number or other designation, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Naming of a Basis of Design product is intended to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification. The drawings indicate the general size, configuration, location, connections and/or support for equipment or systems specified with relation to the other building systems.
- D. Workmanship
1. Remove and replace, at no extra cost, work not in conformance with contract requirements.
  2. Coordinate work and cooperate with other trades to facilitate execution of work.
- E. Coordination with Other Trades
1. Contractor shall give full cooperation and coordination with other trades and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily with the least possible interference or delay.
  2. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans and shop details for the proper installation of the work and for the purpose of coordination adjacent work.
- F. Asbestos or asbestos-containing materials shall not be utilized or allowed on this project. The Contractor shall be rigorous in assuring that all materials, equipment, systems, and components do not contain asbestos. Any deviations from this exclusion shall be remedied at the Contractor's expense without regard to prior submittal approvals.
- G. Access: The Contractor shall specifically consider all materials and equipment installations and shall coordinate with the work of all trades to insure easy and unobstructed accessibility of all systems for operations, maintenance, repairs, and replacement. Installation of all specified materials and equipment including but not limited to, equipment, supports, ductwork, pipe, electrical conduit and controls shall be in a manner which will allow complete unobstructed access to all panels, access doors, filter racks, control boxes, controls actuators, sensors, valves, tube bundles and all other items requiring access for operations or maintenance. All items such as controls, actuators and valves which require servicing or manual operations for system use shall be located such as to be accessible without standing on other equipment, whenever it is possible or practical. Any installation of new equipment or materials which causes problems related to access of new or existing equipment shall be disapproved by the COR and re-accomplished by the Contractor.
- H. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

1.4 ACTION SUBMITTALS

- A. Manufacturer's technical product data, installation instructions and description of accessories for each type to be used and system designation:
1. Access Panels.
  2. Motors and power factor correction capacitors (submit under section specifying related equipment).
  3. Operating and maintenance manuals.
  4. Statement of field instruction completion.

1.5 INFORMATIONAL SUBMITTALS

Welding certificates.

1.6 APPLICABLE PUBLICATIONS

The publications listed in this section form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.7 PROJECT CONDITIONS

- A. References: References to standards, codes, catalogs and recommendations are latest edition in effect on date of invitation to bid.
- B. Refer to applicable contract drawings and specifications pertaining to other Divisions for conditions affecting work.
- C. Definitions: The following are definitions of terms and expressions used in Division 23:
1. Concealed - Hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
  2. Directed - directed by Contracting Officer.
  3. Ductwork - includes ducts, fittings, housings, dampers, supports and accessories comprising a system.
  4. Equal, equivalent - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
  5. Exposed - not concealed.
  6. Piping - includes pipe, fittings, valves, supports and accessories comprising a system.
  7. Removable - detachable from the structure or system without physical alteration of materials or equipment and without disturbance to other construction.
  8. Review - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.
- D. Refer to Division 01, "References" for additional definition of terms.

## 1.8 WARRANTY

Deliver to the COR certificates of equipment warranty extending beyond the guarantee period.

## 1.9 OPERATION AND MAINTENANCE REQUIREMENTS

Provide Operation and Maintenance Manuals in accordance with Section 017823, "Operation and Maintenance Documentation".

## PART 2 - PRODUCTS

## 2.1 ACCESS PANELS

- A. Steel: Prime coated, flush screwdriver operated cam action lock. Minimum size 12 by 16 inches, except as otherwise specified. In acoustical tile ceilings, size to fit full tiles but minimum size 12 by 24 inches; panels shall conform to architectural ceiling panel pattern.
- B. Frame shall have anchor lugs for fastening to construction.
- C. Access panels in plaster and gypsum board surfaces shall be solid flush steel type with expanded metal lath spot welded in place. Frame shall have 2-inch wide lath plaster bond or for gypsum board, a joint compound bead.
- D. Provide UL "B" labeled doors or panels in walls and building elements constructed for a 2-hour fire resistant rating.
- E. Manufacturers: C.E. Sparrow (CESCO), Bilco, Elmdor, Karb, Milcor, Zurn, equal Milcor Styles AP, AT, K, M, and "B" label.

## 2.2 MOTORS AND ELECTRICALLY OPERATED EQUIPMENT

- A. References, Characteristics and Ratings
  - 1. Refer to Electrical Division for requirements of electrical work including starters specified in the Mechanical Divisions.
  - 2. Provide motors and other equipment requiring electrical power or control service suitable for the electrical characteristics indicated on the Electrical Drawings.
  - 3. Horsepower ratings indicated are for manufacturer's equipment upon which the specification is based. Submit proposed deviations from these ratings for review by the COR. Pay costs incurred by deviations, which are permitted.
  - 4. Provide motor rated for 200 volts for 208-volt service. Provide 230 and 460 volt rated motors for 240 and 480 volt service.
  - 5. Brake horsepower rating at specified duty shall not exceed 85 percent of nameplate horsepower rating times NEMA service factor for motors with 1.15 service factor except where other limits are stated for certain equipment, i.e. fans, the maximum load percentage shall be as stated under that equipment times the 1.15 service factor
  - 6. Motors controlled by variable frequency drive (VFD) controllers shall be inverter type motors, compatible and suitable for operation with the VFD provided for this project.



- a. Horsepower ratings of VFD shall be same as motor.
  - b. Provide motor with a maintenance free, circumferential, conductive micro fiber shaft grounding ring equal to Electro Static Technology Aegis SGR bearing protection ring to discharge shaft currents to ground.
- B. Overload Protection
1. Protect each motor, either individually mounted or in unitary equipment, with overload devices such as fuses, thermal cutouts, or thermal protectors installed in each ungrounded conductor serving each motor. Mount these overload devices in the motor controller or in a control panel in unitary equipment.
  2. For equipment that requires the use of fuses, provide the proper size and type of fuses mounted on accessible fuse blocks, integral to the equipment, wired in accordance with applicable codes.
- C. Construction
1. Construct motors in accordance with NEMA Standard Publication MG-1, latest edition, and the applicable IEEE standards.
  2. Frame sizes in accordance with NEMA Standard MG-1 and MG-13, latest editions.
  3. Starting torque, NEMA Design B, 2-4 percent slip.
  4. Starting (locked rotor) kVA as required by the driven equipment. On motors with a locked rotor indicating code letter of "F" or higher, the manufacturer shall notify the electrical contractor for circuit breaker adjustment in accordance with Division 26, "Electrical."
  5. Indoor, General Use: Open dripproof construction, 1.15 service factor.
  6. Rotor: Random-wound, squirrel cage.
- D. Insulation: NEMA Insulation Class B for operation in 40 degrees C ambient; except NEMA Premium efficient motors and motors used in conjunction with variable frequency drive controllers shall be NEMA Class F insulation with horsepower rating based on Class B rise. Where motors operate in a maximum ambient temperature above 40 degrees C, provide motors suitably designed for the ambient temperature indicated, employing a different class of insulation or having a change in frame size, i.e., the ambient temperature plus motor full load temperature rise plus 10 degrees C shall not exceed the temperature rating of the insulation system.
- E. Power Factor Correction Capacitors: Three-phase, rated for the applied circuit voltage, fused at 5 KVAR's and above. Employ non-PCB impregnated paper or film dielectric and insulation; installed in indoor dustproof NEMA Type 12, or outdoor NEMA Type 3R enclosure, depending on location; contain maximum of 3 gallons of a combustible insulating liquid; equipped with integral discharge resistors to reduce voltage to a maximum of 50 volts in three minutes.

Power factor correction capacitors shall be sized by the motor manufacturer. List the capacitor KVAR, the full load current of the motor-capacitor combination to enable proper sizing of the overload protection and the corrected power factor at no load and full load on the shop drawings for the equipment. Do not provide power factor correction capacitors for motors served by a variable frequency drive or motors with reduced voltage starting. Do not provide power factor correction capacitors for fans that have dual motors mounted on a single common shaft and with other drive arrangements that rotate both motors.

1. Individual single speed, non-reversing motors, 5 HP and larger, having a full load power factor of less than 90 percent, shall be supplied by the equipment supplier, with power factor correcting capacitors that correct the full load power factor of the circuit to a minimum of 90 percent and the no load power factor to a maximum of unity.

2. On single speed, non-reversing motors started by reduced voltage controllers such as star-delta, auto transformer, primary resistor, etc., provide necessary contactors and interlocks to prevent insertion of capacitor until controller and motor are operating in the full run mode. Full load power factor of the circuit shall be a minimum of 90 percent.
3. Provide multiple speed motors with capacitors for the full speed mode. Provide necessary contactors and interlocks to permit insertion only on the full speed mode. Full load, full speed power factor of the circuit shall be a minimum of 90 percent.
4. On package or unitized equipment on which motors and controls are factory wired up to a point or points of power connection, install and connect power factor correction capacitors to the motor circuits between the starters and the motors, as part of the factory supplied assembly.

**F. Single Phase Motors**

1. 1/6 Horsepower or Less: Split phase capacitor start, permanent split capacitor or resistance start, capacitor run.
2. 1/4 and 1/3 Horsepower: Capacitor starts.
3. Bearings: "Life-time" sealed ball bearing type, oilable ball bearing or sleeve type.
4. High efficiency energy saving type with a minimum efficiency of 70 percent and a minimum full load power factor of 77 percent.

**G. Three Phase Motors:**

1. NEMA Premium efficiency polyphase induction type.
2. Minimum full load power factor before power factor correction of horizontal and vertical shaft motors shall be as follows:

<b>HP</b>	<b>RPM</b>	<b>POWER FACTOR</b>
1/2	3600 and 1800	70 Percent
3/4	3600 and 1800	70 Percent
1, 1-1/2 and 2	3600 and 1800	79 Percent
3 to 30	3600 and 1800	85 Percent

3. Minimum efficiency (in percent) of horizontal and vertical shaft motors shall be follows:

**Open Dripproof (ODP) Motors**

HP	1200 RPM	1800 RPM	3600 RPM
	Minimum Full Load Efficiency (%) (6-Pole)	Minimum Full Load Efficiency (%) (4-Pole)	Minimum Full Load Efficiency (%) (2-Pole)
1	82.5	85.5	77.0
1-1/2	86.5	86.5	84.0
2	87.5	86.5	85.5
3	88.5	89.5	85.5
5	89.5	89.5	86.5
7-1/2	90.2	91.0	88.5
10	91.7	91.7	89.5

15	91.7	93.0	90.2
20	92.4	93.0	91.0
25	93.0	93.6	91.7
30	93.6	94.1	91.7

NOTE: Efficiencies are nameplate ratings and must be tested in accordance with IEEE Standard 112, Method B.

Totally Enclosed Fan Cooled (TEFC) Motors

HP	1200 RPM	1800 RPM	3600 RPM
	Minimum Nominal Efficiency (%)	Minimum Nominal Efficiency (%)	Minimum Nominal Efficiency (%)
1	82.5	85.5	77.0
1-1/2	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7-1/2	91.0	91.7	89.5
10	91.0	91.7	90.2
15	91.7	92.4	91.0
20	91.7	93.0	91.0
25	93.0	93.6	91.7
30	93.0	93.6	91.7

NOTE: Efficiencies are nameplate ratings and must be tested in accordance with IEEE Standard 112, Method B.

4. Measure motor efficiencies as tested in accordance with ANSI/IEEE Standard 112, Test Method B. Do not extrapolate efficiencies from other data. Measure each horsepower rated size. Submit test data from certified independent testing laboratory of standard manufacturer run per horsepower rated size.

H. Bearings and Bases

1. Motors 1/2 through 2 Horsepower: Sealed "life-time" ball bearing or regreaseable ball bearing type with minimum life of 25,000 hours under "V" belt load conditions.
2. Motors 3 through 30 Horsepower: Anti-friction bearings sized for a minimum life of 25,000 hours under "V" belt load conditions or a minimum life of 100,000 hours for a direct connected load. House bearings in a re-greaseable race with provision for purging old grease. Preload bearings with a bearing load spring to minimize noise and increase bearing life.
3. Motors for Belt Drive: Cast iron or steel base with slide rails having screw adjustments.

2.3 HANGER ATTACHMENT - Application and Type

- A. Concrete (New): Iron or steel inserts. Expander type anchors, specified for existing may be used provided concrete is clear of conduit for drilled depth.
- B. Concrete (Existing): Double plated expander type anchors. Phillips, Hilti or approved equivalent. Loads shall not exceed 1/4 of tested pullout (or shear) strength.

- C. Steel Beams: Iron or steel beam clamps.
- D. Brick or Block Walls: Brackets fastened with self-drilling anchors or toggle bolts, light duty; or through bolts with backplates, heavy duty.

## 2.4 SLEEVES AND ESCUTCHEON PLATES

- A. Sleeves for Conduits - Material and Application
  - 1. Galvanized Standard Weight Steel Pipe:
    - a. Interior concrete walls.
    - b. Interior masonry walls
  - 2. 22 Gage Galvanized Steel:
    - a. Stud partitions.
    - b. Suspended plaster and gypsum board ceilings.
- B. Sleeves for Ductwork: 20 gage galvanized steel.
- C. Sealant: One part polysulfide, equivalent to Pecora Synthacaulk GC24 or polycarbonate, equivalent to Proseal 34 for general use.

## PART 3 - EXECUTION

### 3.1 ACCESS PANELS

- A. Provide access panels or doors that are indicated or required for access to coils, fire dampers, smoke dampers, control devices, and to concealed mechanical and electrical devices which may require future inspection, repair or adjustment; and elsewhere as required by applicable codes.
- B. Use ceiling element as access panel in suspended metal pan, lay-in panel, and accessible tile ceilings.
- C. Attach a 1/4-inch diameter color-coded aluminum tag to exposed grid tees or ceiling elements used as access panels and recessed pan doors.
- D. Acoustic Tile Ceiling: Fit frame with anchoring devices for suspension system.

### 3.2 MOTORS AND ELECTRICALLY OPERATED EQUIPMENT

- A. Align motor, drives, and driven equipment to avoid excessive strain or wear.
- B. Check belt tension with a tension tester for the deflection force recommended by the manufacturer. Check and adjust tension after several minutes operation and then after eight hours of operation.
- C. Power factor correction capacitors for individual motors are installed and connected under the Electrical Division. Coordinate with the Electrical Contractor.

- D. Install shaft grounding ring on shaft of motors served by variable speed drives in accordance with manufacturer's recommendations and instructions.

### 3.3 HANGER ATTACHMENT

Select and install structural attachments for hangers supporting pipes, ducts, conduit and equipment adequately for stresses to which they may be subject and for proper distribution of load to building structural members.

### 3.4 SLEEVES AND ESCUTCHEON PLATES

- A. Install sleeves for pipes and conduits passing through plaster ceilings, gypsum board ceilings, walls, partitions, air handling unit casings, structural members, and other building parts. Install sleeves in time to permit construction progress as scheduled.
- B. Install sleeves for ducts passing through walls, plaster ceilings, gypsum board ceilings, and partitions as follows:
  - 1. Where Vermin Control is indicated.
  - 2. Walls with waterproofing.
  - 3. Fire-rated walls
- C. Install sleeves with length to pass through full thickness of construction.
- D. Provide 1/2-inch minimum clearance between sleeve and conduit, pipe, duct or covering. Center conduit, pipe or duct in sleeve unless otherwise indicated. Insulation thickness specified for use through sleeves requiring vermin proofing shall be as specified but not less than 1-inch minimum thickness. Refer to Section 230700 Mechanical Insulation.
- E. Install ends of sleeves flush with finished wall surfaces.
- F. Hem edges of duct sleeves extending above floor.
- G. Reinforce sleeves temporarily, if necessary, to preserve accurate shape without distortion during construction.
- H. Grout sleeves in and concrete walls into building structure to make joint watertight.
- I. Install escutcheon plates for conduits at ceilings, walls, and partitions in finished areas unless otherwise indicated.
  - 1. Fit escutcheons around conduit.
  - 2. Outside diameter shall cover sleeve.
- J. Pack annular space between sleeve and conduit or duct and voids between building construction and conduit, duct, or sleeves as follows:
  - 1. Firestop equal to U.S. Gypsum Thermafiber, caulked at both ends to manufacturer's recommended depth with sealant, for the following sleeve locations:
    - a. Where vermin control is indicated.
    - b. Walls with waterproofing.
  - 2. For the following locations, pack annular space between sleeve and conduit or duct and voids between building construction and conduit or duct sleeves with industrial felt equal

to U.S. Gypsum Thermafiber, caulked at both ends to manufacturer's recommended depth with sealant, or code approved firestopping foam, caulk, or putty that meets ASTM E-814 with UL classification. Sealants shall not contain toxic or flammable solvents and shall not produce toxic or flammable outgasing during any stage of application, curing, drying or fire conditions.

- a. Smoke Barriers.
  - b. Fire Rated Walls.
3. See Section 230700, "Mechanical Insulation," for fire stop insulation on pipes and ducts through sleeves.
- K. Prime surfaces prior to caulking to obtain good adhesion where recommended by sealant manufacturer.
- L. Vermin Control: Provide vermin control for conduits and ducts passing through ceilings, walls, and partitions.
- M. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- 1. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

### 3.5 PROJECT RECORD DOCUMENTS

Maintain at the site one set of black or blue line on white prints of drawings, copies of specifications, addenda, shop drawings reviewed by COR, change orders and other modifications in good order and marked in red ink to record changes made during construction. Deliver these in final complete form to the Contracting Officer upon completion of work.

### 3.6 MATERIAL AND EQUIPMENT LIST

- A. Submit for COR's review a list of subcontractors' and manufacturers' names for items proposed for the work within 15 days after award of the contract.
- B. Failure to submit list or name manufacturers acceptable to COR within time limit will result in COR selecting a list of manufacturers, and selection shall be binding upon Contractor.

### 3.7 SHOP DRAWINGS AND DESCRIPTIVE DATA

- A. Submit electronic copies, in accordance with Division 01 of manufacturer's shop drawings and descriptive data.
- B. Establish that the physical and functional character of each item including, size, type and required service access is suited for its intended location and use.
- C. Coordinate drawings and data before submitting and certify that provisions of the contract documents have been met.
- D. Call attention, in writing, to deviations from contract requirements.

- E. Do not fabricate, deliver to site, or install items requiring shop drawing review, until the review has been completed by the Contracting Officer and the shop drawing has been marked to indicate "No Exception Noted" or "Make Corrections Noted."
- F. Specifically identify pertinent project data on the shop drawings.
- G. Include Operation and Maintenance Data.
- H. Use only final or corrected drawings and data for construction.
- I. The COR's review of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the requirements of this contract is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work.

**3.8 SITE EXAMINATION**

Failure to visit site and become familiar with local conditions prior to bidding will not relieve the Contractor of his responsibility for complying with the Contract Documents.

**3.9 PERMITS**

- A. Obtain and pay for permits where required by air and water quality control regulations.
- B. Obtain and pay for required permits.

**3.10 CUTTING AND PATCHING**

- A. Unless otherwise directed, do cutting and patching. Repair damaged fireproofing and waterproofing to original or better condition.
- B. Do not cut walls, floors, reinforced concrete or structural steel without COR's permission. Install services without affecting reinforcing steel.

**3.11 CLEANING UP**

- A. Keep premises free from accumulation of debris.
- B. Remove tools, scaffolding, surplus material, debris, and leave premises broom clean.
- C. On discontinuance of part of the work, place debris in containers and promptly remove them from the County's property.

**3.12 WORK IN EXISTING BUILDINGS**

- A. Conditions of Occupancy

1. This building will be occupied during the life of this contract. Execute work in a manner to impose minimal interference with the normal functioning of the building and its occupants. When interference is unavoidable, schedule work 14 days in advance with the COR.
  2. Make temporary connections where necessary to maintain uninterrupted electrical, plumbing, and heating service.
  3. Provide adequate protection for the building, its contents, and occupants.
  4. Perform work as quietly as possible to avoid unnecessary disturbance. Unusual precaution may be necessary in the conduct of work in some areas to achieve satisfactory compliance.
  5. Coordinate with COR to perform sheet metal work, masonry demolition, or other work producing high noise levels, dust, or hazards to occupants in occupied areas.
  6. Comply with regulations of COR pertaining to circulation, sanitation, and behavior of Contractor's personnel.
  7. No impact driven piling shall be permitted. Minimum use of impact tools shall be limited to handheld tools and shall be scheduled 5 days in advance with COR.
- B. Field Office, Storage, and Loading Facilities
1. Use only those toilet facilities designated by the COR for use by Contractor's personnel.
  2. Store equipment and materials in areas designated by COR in a manner which will not (a) cause concentrations of weight potentially damaging to building structure, (b) impede normal building traffic, or (c) be a hazard to occupants.
  3. Use only the entrance designated by the COR for delivery and removal of materials. Schedule deliveries and removals with the COR in advance. Unscheduled traffic must give precedence to COR's usage. Do not impede access through doorways and corridors with materials, containers, or parked conveyances.
  4. Use only rubber wheeled wheelbarrows, dollies, or carts over finished floor.
  5. Keep office, storage, and loading areas neat and clean.
- C. Barricades
1. Erect temporary barriers for protection of occupants, building, and building contents.
  2. Where partitions separating occupied areas must be cut, close hole with tight fitting temporary plywood closure panel, 1/2-inch minimum thickness, to form visual and acoustical barrier.
  3. Protect exposed holes in floors in accordance with applicable codes and regulations.
  4. Enclose dust-producing operations with plastic sheets or drop cloths to prevent the spread of dust into occupied areas. Maintain a negative pressure environment relative to the surrounding spaces.
    - a. Take the necessary precautions to prevent the spread of dust and dirt through the existing HVAC system, including outdoor intakes. Protect supply, return and exhaust air openings.
- D. Alterations
1. Cut, alter, remove or temporarily remove and replace existing work necessary for installation of mechanical and associated electrical work. Maintain the necessary clearances for accessibility or compliance with code around existing equipment, devices, etc., that are to remain.
  2. Verify dimensions of existing building elements pertaining to the installation of new work to assure physical compatibility prior to fabrication or installation.
  3. Where the installation of new services or the extension of existing services requires cutting of existing floors, walls, partitions, etc., check for the presence of existing mechanical and electrical services within or immediately beneath construction and exercise necessary precautions to prevent damage to the service or injury to personnel



due to contact with same. Where practical, temporarily disconnect such existing service during the cutting operation. Schedule such outages in service with the COR, 14 days in advance.

**E. Furnishings and Equipment**

1. Identify, to the COR at the time work is scheduled, movable furnishings and equipment which interfere with the progress of the work.
2. Protect remaining furnishings and equipment in work area, both movable and fixed, with drop cloths, batting or other means to prevent damage.

**F. Removal of Materials and Equipment**

1. Remove promptly from the site, materials and equipment specified to be removed and not reinstalled or stored.
2. Unless otherwise indicated, removal of pipes, ducts, and equipment includes removal of accessories such as hangers, air outlets, piping connections, junction boxes, starters, etc. and all abandoned and non-operational mechanical system components within limits of the contract. Remove to source or, if concealed, to point of concealment, connections to mechanical equipment required to be removed or disconnected. Terminate connections behind finished surfaces and, if subject to movement, clear of building construction. Cap connections extending from ducts or piping remaining in service. Contractor shall mark all components to be removed and obtain confirmation from COR.

**G. Cleaning Ductwork:** Vacuum clean internally existing ductwork within twenty feet of ductwork modified/replaced under new work.

**H. Connections to Existing Systems**

1. Connect to existing systems as indicated.
2. Obtain permission from COR 14 days in advance if outage of service is necessary to make connections. See the Article titled, "Outages."
3. Repair insulation damaged at points of connection. Restore integrity of vapor barriers and surface finish.

**3.13 PROTECTION**

- A. Protect mechanical and electrical material and equipment from the elements or other injury as soon as delivered on premises.
- B. Cap or plug openings in equipment, duct, and conduit systems, to exclude dirt and other foreign material. Do not use rags, wool, cotton, paper, waste or similar materials for plugging.
- C. Existing components of the building and its systems shall be protected from damage. Any damage to these components shall be repaired or replaced to the satisfaction of the COR. Special care shall be taken with regards to insulation on existing piping and ductwork. Damaged insulation shall be replaced so that the vapor barrier and insulating characteristics of the material match those prior to damage taking place.

**3.14 CLEANING OF SYSTEMS**

- A. Pay for labor and materials required to locate and remove obstructions from systems clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.
- B. Install air filters of equal efficiency to those in permanent air systems operated for temporary heating or air balancing during construction. Replace with clean filters of same efficiency prior to acceptance and after cleaning of system.
  - 1. Replace existing filters in existing systems serving the renovated areas at the discretion of the COR that may have become loaded due to renovation work.
- C. Leave systems clean, and in complete running order.

**3.15 EQUIPMENT SUPPORTS**

- A. Provide equipment supports consisting of platforms, gratings, structural members, hangers, rods, racks, and incidental materials.
- B. Design and construct supporting structures of strength to safely withstand stresses to which they may be subjected and to properly distribute the load and impact over building areas.
- C. Ceiling Suspended Platforms: Construct with steel hangers. Brace and fasten to building structure.
- D. Wall Mounted Platforms: Construct with steel brackets.

**3.16 OPERATING AND MAINTENANCE MANUAL**

- A. Furnish manual bound and indexed containing:
  - 1. Brief description of each system and components.
  - 2. Starting and stopping procedures.
  - 3. Day/night changeover.
  - 4. Seasonal changeover
  - 5. Special operating instructions.
  - 6. Routine maintenance procedures.
  - 7. Schedule for periodic servicing and lubrication.
  - 8. Manufacturers' printed operating and maintenance instructions, parts lists, illustrations and diagrams.
  - 9. Manufacturers' Data Report Form U-1 certifying code compliance for equipment specified to be constructed in accordance with ASME Code for Unfired Pressure Vessels.
  - 10. One final or corrected reviewed copy of each shop drawing and Contractor's drawings.
  - 11. One copy of each wiring and piping diagram.
  - 12. One reviewed copy of certified test reports.
  - 13. Air balancing report.
  - 14. Product warranty information.
- B. Submit to COR for review at least 30 days prior to date it is expected system will be turned over to the County.
- C. After review by COR, submit three copies to the County and one to Engineer of Record.

**3.17 FIELD INSTRUCTION**

- A. Provide operating and maintenance staff demonstrations and training in accordance with Section 018200, "Demonstration and Training".
  - 1. Provide a walking tour, demonstrating all new mechanical equipment, system layout, routing and labeling.
- B. Upon completion of work, instruct County's representatives in the proper operation and maintenance of the mechanical and electrical systems.
- C. Instruction periods specified below shall be in addition to instructions specified for certain items elsewhere in the specifications.
- C. Instructions shall be given by persons expert in the operation and maintenance and shall be for a period of not less than 1 eight-hour day.
- D. Prepare statement(s) for signing by County's representative indicating date of completion of instructions and hours expended. Furnish copy of signed statement to Contracting Officer.

**3.18 OUTAGES**

- A. The purpose of this article is to establish standard procedures for requesting an outage for mechanical, electrical, or operational systems or services associated with the building and physical plant.
- B. An outage is defined as prohibiting or restricting a mechanical, electrical or operational service from routine operation (see attached outage request for service included). For purposes of repair, replacement or connection to an existing system, this standard shall be followed.
- C. All persons requesting an outage shall complete an "Outage Request Form" included at the end of this Section.
- D. Contractor shall submit, in writing with the "Outage Request Forms" a plan on the work to be performed during the outage, including length of time and reason the utility system must be shutdown. Contractor, in conjunction with the COR, shall research and identify all systems affected by Outage as well as locating and listing all components by tag or facility equipment number, and all the action required at each to achieve the outage. Submit written Plan and Outage Form 14 days in advance of requested outage to COR.
- E. All "Outage Request Forms" and the Outage Plan shall be reviewed by the construction foreman or superintendent for feasibility and necessity.
- F. The number and duration of all outages shall be minimized.
- G. A master outage list, with the approximate required dates, shall be submitted to the COR within 14 days from the commencement of work.
- H. All systems when shutdown, shall be tagged in accordance with OSHA lock-out/tag-out procedures.

3.19 ASBESTOS

Should any material resembling asbestos-containing materials be encountered during excavation of work, immediately notify COR for instructions before proceeding.

Attachments: Outage Request Form

END OF SECTION 230500



SECTION 233113 - DUCTS AND DUCT ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

Sheet metal ductwork, insulated flexible ductwork and flexible ductwork.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 – General Requirements
- B. Section 230500 - Basic Mechanical Materials and Methods
- C. Section 230553 – Identification of Mechanical Ductwork and Equipment
- D. Section 230593 - Testing, Adjusting, and Balancing
- E. Section 230700 - Mechanical Insulation
- F. Section 237000 - Heating, Ventilating and Air Conditioning

1.3 QUALITY ASSURANCE

- A. For details not specified, such as hangers, elbow construction, offsets, obstruction streamlining, branch connections, dampers, sealing, the following reference applies:  
  
Sheet Metal and Air Conditioning Contractors National Association "HVAC Duct Construction Standards, Metal and Flexible," Third Edition, 2005 referred to herein as SMACNA-HVAC.
- B. Flexible duct and insulated flexible duct including vapor barrier shall be Class I in accordance with NFPA 90A.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 230500, "Basic Mechanical Materials and Methods".
- B. Manufacturer's technical product data, installation instructions and accessories for the following:  
  
Electric Duct Heaters  
Hot Water Heating Coils  
Access Doors  
Balancing Volume Dampers  
Barometric Relief Dampers  
Round Duct and Fittings  
Insulated Flexible Duct  
Sealant Compound

1.5 INFORMATIONAL SUBMITTALS

Statement indicating compliance with SMACNA standards and specified system pressure ratings.

1.6 APPLICABLE PUBLICATIONS

The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.7 PROJECT CONDITIONS

- A. Physical Interference: Provide offsets or changes in duct shape required to avoid structural or other interference without additional cost to the County.
- B. Ductwork dimensions indicated on the drawings are internal.
- C. System Pressure Rating: Construct systems in accordance with the following pressure rating.

<b>SYSTEM</b>	<b>PRESSURE RATING (INCHES- W.G.)</b>
AHU Return and Outdoor Air Ductwork	(-)4
AHU Supply Ductwork	4

**PART 2 – PRODUCTS**

2.1 ELECTRIC DUCT HEATERS

- A. Heaters shall be UL listed for zero clearance.
- B. Heaters and controls shall meet current National Electrical Code requirements.
- C. Submit coordinated wiring diagrams for Contracting Officer's Representative's (COR) review.
- D. Factory test wiring and control operation.
- E. Capacities as indicated on drawings.
- F. Sizes shall be equal to indicated duct or casing sizes.
- G. Type A: Open helical coils of 80 percent nickel, 20 percent chromium alloy resistance wire supported by ceramic insulating bushings mounted in brackets spaced on 4-inch maximum centers. Maximum density of 35 watts per square inch of outside wire surface area.
- H. Stainless steel element terminals and nuts.
- I. Galvanized or aluminized steel casing and supports, spot welded to form rigid frame. Casings shall have continuous flanged connections independent of terminal box except for single duct heaters, which shall be slip-in type.

- J. Provide automatic reset high limit thermal cutout to de-energize all circuits. Where heater rating or multiple circuiting exceeds control capacity, provide magnetic contactor(s), UL listed for 100,000 cycles, for pilot control by cutout. Control sensor on hot deck heaters and other heaters of 72 inches or greater width shall span heater width and respond to highest temperature on any 12-inch portion.
- K. Provide high limit thermal cutout(s) with manual reset button external to box, to deenergize circuits. Where heater ratings or multiple circuiting exceeds control capacity provide magnetic contactor(s), UL listed for 100,000 cycles, for pilot control by cutout. Replaceable thermal cutouts may be employed in lieu of manual reset type. If replaceable cutouts are provided, opening shall be detectable without removal from terminal box and shall be replaceable without disturbing heater. Identical cutouts shall be used in all heaters and one spare shall be furnished to County for every ten cutouts up to a maximum of ten. Setting shall be higher than that for automatic reset cutout.
- L. Where rating of heater exceeds permissible single circuit limit, provide properly rated fuses for each circuit in fuse block.
- M. Circuit heaters for SCR control. Where multiple steps are required adjacent rows of elements shall be connected to different circuits in progressive sequence to minimize stratification during part load operation.
- N. Power source voltage as indicated on the Electrical Drawings. Provide integral disconnect.
- O. Circuit 3-phased heaters for balanced phase loading.
- P. If power voltage exceeds 240 volts, provide 120-volt control transformer; with primary fuse protection if total heater load exceeds 16 amperes.
- Q. Provide NEMA 1 control panel enclosures with automatic temperature control device furnished by the automatic control system subcontractor, switches, cutouts, fuse blocks, contactors, and controls mounted and factory wired to terminal blocks for connection to power and external control. Provide integral panel for each heater.

Furnish remote control panel enclosures for heaters. Remote panels shall contain all items other than automatic and manual reset cutouts, thermal cutouts and air flow switches, which shall be contained in the heater terminal enclosure.

Heater terminal and panel enclosures shall have hinged covers. Insulate inside panel of enclosures to prevent condensation. Provide adequate ventilation for temperature sensitive or heat producing equipment, such as SCR controller. Provide unfused disconnect switch for each control panel enclosure interlocked to prevent door from being opened unless switch is open, and where control panel is remote from heater, means of padlocking switch in open position.

Remote control panels shall be provided with fuses in all phases of each sub-circuit to protect wiring between panel and heater terminal enclosure.

Provide pilot light in remote panel door of each heater functioning as central air handling unit equipment and as indicated. Pilot light shall glow when heater is energized.

- R. Manufacturers: Brasch, Indeeco.

## 2.2 HEATING COILS

- A. Coil ratings shall be ARI certified /or certified by the manufacturer to provide ratings in accordance



with ARI Standard 410.

- B. Protect coils from damage during shipment. Replace coils that have loose or damaged fins or tubes.
- C. Refer to drawings for duty and other physical requirements.
- D. Coils: Smooth helical or plate fins of 0.0085-inch minimum thickness aluminum. Helical copper fins shall be solder bonded to tubes. Working pressure ratings: 200 psi (1380 kPa) for water coils.
- E. Casings: Minimum 16 gage galvanized steel except minimum 20 gage galvanized steel for single heating coils not exceeding 3-foot-6-inch tube length.
- F. Headers: Supply and return connections at same ends. Construct headers of steel, cast iron, or copper. Paint cast iron and steel headers after fabrication with primer coat of aluminum paint.
- G. Water Coils: Serpentine type with vent and drain header connection.
- H. Manufacturers: Aerofin, Bohn, Carrier, Dunham-Bush, Heat-craft, McQuay, Miller-Picking, Pace, Temptrol, Trane, York.

## 2.3 FITTINGS AND ACCESSORIES

- A. Elbows
  - 1. Provide 90-degree elbows of radius construction wherever space permits and elsewhere of square construction. Construct 90-degree square elbows with double radius turning vanes unless otherwise indicated. If throat radius on curved elbows must be less than duct width, provide full-length metal turning vanes. Provide 3/4-inch trailing edge on turning vanes of 90 degree square elbows wherever elbow is less than one duct perimeter upstream of change in duct size or direction.
  - 2. Where a size change must occur at a square elbow, extend runners from throat to heel and secure vanes on runners parallel with duct sides.
  - 3. Unless otherwise indicated, provide offsets with 30-degree full radius elbows as maximum.
- B. Flexible Collars: Provide 6-inch wide neoprene impregnated glass fabric collars between fans and ducts or casings, and wherever ducts cross building expansion joints. Collars shall have flame retardant to have flame spread index not over 25 and a smoke developed index not over 50.
- C. Duct Access Door Construction: SMACNA-HVAC, Fig. 7-2, Door A, Frame 1, Hinge Position 1 for 2-inch w.g. static pressure rating and less.
- D. Barometric Relief Dampers
  - 1. Suitable for horizontal or vertical mounting.
  - 2. Maximum Air Velocity: 1000 fpm.
  - 3. Maximum System Pressure: 0.35-inch wg.
  - 4. Frame: Hat-shaped, 0.05-inch thick, galvanized sheet steel, with welded corners and mounting flange.
  - 5. Blades:
    - a. Multiple, 0.025-inch thick, roll-formed aluminum sheet.
    - b. Maximum Width: 6 inches.

- c. Action: Parallel.
  - d. Balance: Gravity.
  - e. Eccentrically pivoted, Off-center pivoted, or End pivoted.
  - 6. Blade Seals: Neoprene.
  - 7. Blade Axles: Galvanized steel.
  - 8. Tie Bars and Brackets:
    - a. Material: Galvanized steel.
    - b. Rattle free with 90-degree stop.
  - 9. Return Spring: Adjustable tension.
  - 10. Bearings: Synthetic.
  - 11. Accessories:
    - a. Flange on intake.
    - b. Adjustment device to permit setting for varying differential static pressures.
  - 12. Manufacturers: Air Balance, American Warming and Ventilating, Cesco, Greenheck, Nailor, Ruskin.
- E. Balancing Volume Dampers
- 1. Pressure Rating 2 inch W.G. and Less: SMACNA-HVAC, 7-4 A, B, C, 12-inch maximum blade width no internal frame. Fig. 7-5, multi opposed blade larger than 12-inch duct height, 8-inch maximum blade width. Recess frame totally out of airstream. Limit stop penetration into airstream to 1/2-inch. Dampers less than 5 feet upstream of outlets, equivalent to Young Regulator No. 820.
  - 2. Locate where accessible for adjusting after completion of work. Provide access panels where regulators are concealed. Provide damper regulators equal to "Ventlok" models listed.
    - a. Concealed or Exposed in Unfinished Space: No. 641.
    - b. Manufacturers: Linx Industries, Ventfabrics, Young Regulator.
- F. Instrument Test Holes: Locate where accessible in main or major branch ducts and upstream of smoke detectors to permit measurement of fan air quantities according to ASHRAE Pitot tube method. Locate holes on more than two sides of larger duct if required by available Pitot tube length. Provide holes with 1-inch high Ventlok No. 699 instrument ports.
- G. Plenum Connections: Provide bellmouth type for round supply ducts connecting to apparatus casings; maximum 20 degrees transition angle for rectangular ducts.
- 2.4 RECTANGULAR DUCTWORK - PRESSURE RATED 4-INCH W.G. AND LOWER
- G90 Galvanized steel sheets, reinforcing and companion angles, and hangers. Provide metal specification, gages and construction of seams, joints and reinforcing according to SMACNA-HVAC.
- 2.5 ROUND DUCTWORK - PRESSURE RATED 4-INCH W.G. AND LOWER
- A. G90 Galvanized steel ducts, reinforcing, joining angles and hangers. Metal specification, gages and construction of ducts according to SMACNA-HVAC.
  - B. Unless otherwise indicated, 90 degree elbows shall be 5 sections or die formed; and 90 degree branch connections shall be long or bell formed conical.

- C. Manufacturers: Spiral conduit and fittings - Eastern Sheetmetal, Hamlin, Lindab, McGill Airflow Corp., Monroe, Semco.

## 2.6 INSULATED FLEXIBLE DUCT

- A. Spiral wound metal reinforced coated glass fabric, factory insulated with 1-inch, 3/4 pound density insulation with flexible outer vapor barrier, equal to Thermaflex M-KC.
- B. Duct shall be rated for 10-inch w.g. positive, 2-inch w.g. negative pressure, 0 to 180 degrees F continuous temperature, and 4000 fpm air velocity.
- C. Manufacturers: Flexmaster, Genflex, Thermaflex, Wiremold.

## 2.7 GASKETS

3M Company EC-1202 tape sealer. Minimum size and thickness 1 by 1/8-inch.

## 2.8 SEALING COMPOUND

Childers CP-146, McGill Airseal Corp. "United Duct Sealer," Foster 32-19, Hardcast, Inc.

## PART 3 - EXECUTION

### 3.1 ELECTRIC DUCT HEATERS

- A. Locate heaters at least two times duct width plus height downstream of fans, elbows, branch connections.
- B. Install heaters with coils in vertical position.
- C. Allow clearance for removal of slip-in heaters and terminal box door swing.
- D. Maintain NEC clearance.
- E. Connect wiring in accordance with Division 26.

### 3.2 HEATING AND COOLING COILS

- A. Protect coils from damage during installation. Replace coils that have loose or damaged fins or tubes.
- B. Accurately level water coils on supports.

### 3.3 FITTINGS AND ACCESSORIES

- A. Damper and Coil Frames: Bolt and seal damper and coil frames to duct.
- B. Provide duct accessories of materials suited to duct materials; use galvanized steel accessories in galvanized steel ducts.
- C. Vibration: Brace or reinforce ducts where necessary to overcome vibration, buckling or breathing.

- D. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- E. Barometric Relief Dampers: Install in accordance with manufacturer's instructions and recommendations.
- F. Balancing Volume Dampers
  - 1. Install a minimum of two duct widths from air inlet or outlet device.
  - 2. Mark balanced position.
  - 3. Elevate dial to face of insulation.
- G. Secondary Drain Pans
  - 1. Locate top of secondary drain pan 6 inches below bottom of air handling unit.
  - 2. Wire water level detection device to local alarm shown on drawings. Send an alarm signal to building automation system.
- H. Install airtight duct access doors in casings, plenums, and ducts to allow for inspecting, adjusting, and maintaining accessories as follows:
  - 1. On both sides of duct coil.
  - 2. Downstream from dampers, turning vanes and equipment.
  - 3. Adjacent to fire dampers, providing access to reset or reinstall fusible link.
  - 4. To interior of casings, plenums, and ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
  - 5. Locate on sides of ducts where adequate clearance is available, otherwise locate on bottom of ducts.
  - 6. Install the following sizes for duct-mounting, rectangular access doors:
    - a. One-Hand or Inspection Access: 8 by 5 inches.
    - b. Two-Hand Access: 12 by 6 inches.
    - c. Head and Hand Access: 18 by 10 inches.
    - d. Head and Shoulders Access: 21 by 14 inches.
    - e. Body Access: 25 by 14 inches.
    - f. Body Plus Ladder Access: 25 by 17 inches.
  - 6. Install the following sizes for duct-mounting, round access doors:
    - a. One-Hand or Inspection Access: 8 inches in diameter.
    - b. Two-Hand Access: 10 inches in diameter.
    - c. Head and Hand Access: 12 inches in diameter.
    - d. Head and Shoulders Access: 18 inches in diameter.
    - e. Body Access: 24 inches in diameter.

### 3.4 RECTANGULAR DUCTWORK - PRESSURE RATED 2-INCH W.G. AND LOWER

- A. Construct ducts true to indicated dimensions, straight and smooth on inside with neatly finished airtight joints.
- B. Where rigid board insulation is applied, do not use cross break or bead construction.
- C. Construct the sides of a section of duct of gage specified for its maximum dimension.

- D. Seal seams and joints in outdoor ductwork with sealing compound protected with weather resistant tape.
- E. Seal transverse joints, fitting connections and snaplock seams in indoor ductwork with sealing compound and tape.

**3.5 ROUND DUCTWORK - PRESSURE RATED 2-INCH W.G. AND LOWER**

- A. Clean and paint welds with zinc dust paint.
- B. Seal transverse joints, fitting connections and snaplock seams in indoor ductwork with sealing compound and tape.

**3.6 INSULATED FLEXIBLE DUCT**

- A. Provide on connection to round neck supply air ceiling diffusers.
- B. Runs of insulated flexible duct shall not to exceed five feet in length.
- C. Install without kinks and compressions. Support duct with minimum 1-inch wide band hangers to avoid sagging. Supports shall conform to SMACNA Fig. 3-10.
- D. Provide bends with throat radius not less than outside diameter of insulated flexible duct.
- E. Provide duct elbow support at locations where an elbow connection is provided.
- F. Seal insulation at ends and other openings to maintain continuity of vapor barrier. Secure joints with pressure sensitive tape and clamps. Insert high-density sections of insulation between vapor barriers and duct under clamps to maintain insulation thickness.
- G. Install in accordance with manufacturer's instructions and recommendations.

**3.7 GASKETS**

Overlap gaskets at corners and ends.

**3.8 SEALING COMPOUND**

Follow manufacturer's recommendations. If necessary to achieve an airtight joint, additionally apply duct tape to wet sealant compatible with the sealer used. Allow adequate curing time before pressurizing system.

END OF SECTION 233113

ATC GENERAL NOTES (APPLIES TO ALL ATC WORK)

- ALL AUTOMATIC TEMPERATURE CONTROLS (ATC) SHALL BE DIRECT DIGITAL CONTROLS (DDC) AND SHALL BE INTEGRATED INTO THE EXISTING JCI METASYS BUILDING AUTOMATION SYSTEM (BAS) FOR THE FOLLOWING SCHOOLS: DOES, FES, GHS, HCMIS, OIHS, AND RHHS. THE DIRECT DIGITAL CONTROLS SHALL BE INTEGRATED INTO THE EXISTING HONEYWELL TRidium BAS FOR THE FOLLOWING SCHOOLS: ELMS, GCS, HSES, MWMIS, AND VES. ALL ATC WORK SHALL BE PERFORMED BY INSTALLERS AUTHORIZED BY THE BAS MANUFACTURER.
- THE BAS CONTROLS SHALL UTILIZE ELECTRONIC SENSING, MICROPROCESSOR-BASED DIGITAL CONTROL, AND ELECTRONIC ACTUATION OF DAMPERS AND VALVES OR PROVIDE ANALOG PRESSURE TRANSDUCER TO CONVERT DDC VOLTAGE INTO PNEUMATIC SIGNAL PRESSURE FOR ALL EXISTING PNEUMATIC HEATING OR COOLING WATER VALVE ACTUATORS, EQUAL TO VERIS EP2100S.
- THE ATC CONTRACTOR SHALL PROVIDE ALL CONTROLLERS, CONTROL DEVICES, CONTROL PANELS, SOFTWARE, PROGRAMMING, AND INPUT/OUTPUT, POWER, AND NETWORK WIRING REQUIRED TO CONTROL THE HVAC EQUIPMENT AND CONNECT THE HVAC EQUIPMENT TO THE BAS. NETWORK INTERFACE COMMUNICATION SHOULD MATCH THE EXISTING BUILDING BAS NETWORK PROTOCOL.
- IF COMMUNICATION IS LOST BETWEEN THE UNIT CONTROLLER AND THE BAS, THE UNIT CONTROLLER SHALL OPERATE USING DEFAULT MODES AND SETPOINTS.
- EXCEPT AS OTHERWISE INDICATED, PROVIDE MANUFACTURER'S STANDARD MATERIALS AND COMPONENTS AS PUBLISHED IN THEIR PRODUCT INFORMATION, DESIGNED AND CONSTRUCTED AS RECOMMENDED BY THE MANUFACTURER, AND AS REQUIRED FOR THE APPLICATION INDICATED.
- ALL INPUT/OUTPUT POINTS SHOWN IN THE DDC POINT LISTS SHALL BE HARDWIRED TO THE BAS.
- GRAPHICS SHALL BE PROVIDED ON THE BAS FOR ALL EXISTING AND NEW INPUT/OUTPUT POINTS SHOWN IN THE DDC POINT LISTS. GRAPHICS SHALL IDENTIFY THE CURRENT MODE OF OPERATION, SETPOINTS, AND CURRENT VALUES OF ALL POINTS. ALL SETPOINTS SHALL BE ADJUSTABLE.
- OCCUPIED/UNOCCUPIED MODES OF OPERATION SHALL BE DETERMINED BY THE TIME SCHEDULE OF THE BAS.
- ALL WIRING SHALL BE INSTALLED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND SHALL BE INSTALLED WITHIN CONDUIT (EMT - INDOORS, RIGID STEEL - OUTDOORS) IN EXPOSED OR CONCEALED, INACCESSIBLE LOCATIONS. UL PLENUM RATED CABLE INSTALLED ON J-HOOKS IS ACCEPTABLE FOR CONCEALED, ACCESSIBLE LOCATIONS FOR COMMUNICATIONS AND SIGNAL WIRING. J-HOOKS SHALL BE PROVIDED AT INTERVALS NOT EXCEEDING 60 INCHES. CABLES SHALL BE SECURED WITH VELCRO CABLE STRAPS (PLASTIC CABLE TIES ARE NOT ACCEPTABLE). 24VAC POWER WIRING SHALL BE METAL CLAD (MC) CABLE AND SECURELY FASTENED.
- COMMUNICATION WIRING:
  - LOCAL SUPERVISORY LAN: CATEGORY 6 OF STANDARD TIA/EIA (100/1000BASET). NETWORK SHALL BE RUN WITH NO SPLICES AND SEPARATE FROM ANY WIRING OVER 30 VOLTS.
  - PRIMARY AND SECONDARY CONTROLLER LANS: INDIVIDUALLY 100% SHIELDED PAIRS PER MANUFACTURER'S RECOMMENDATIONS FOR DISTANCES INSTALLED, WITH OVERALL PVC COVER, CLASS 2, PLENUM-RATED. COMMUNICATION WIRING SHALL BE RUN WITH NO SPLICES AND SEPARATE FROM ANY WIRING OVER 10 VOLTS. SHIELD SHALL BE TERMINATED AND WIRING SHALL BE GROUNDED AS RECOMMENDED BY BAS MANUFACTURER.
- SIGNAL WIRING TO ALL FIELD DEVICES INCLUDING, BUT NOT LIMITED TO, ALL SENSORS, TRANSDUCERS, TRANSMITTERS, SWITCHES, ETC. SHALL BE TWISTED, 100% SHIELDED PAIR, MINIMUM 18-GAUGE WIRE, WITH PVC COVER. SIGNAL WIRING SHALL BE RUN WITH NO SPLICES AND SEPARATE FROM ANY WIRING OVER 30 VOLTS. SHIELD SHALL BE GROUNDED AT CONTROLLER END ONLY UNLESS OTHERWISE RECOMMENDED BY THE CONTROLLER MANUFACTURER.
- FUNCTION OF CONTROLS SHALL BE AUTOMATICALLY RESTORED TO NORMAL OPERATION WITHOUT OPERATOR INTERVENTION WHEN SAFETIES ARE MANUALLY RESET OR WHEN POWER IS RESTORED AFTER AN OUTAGE. LOW LIMIT TEMPERATURE SENSORS AND HIGH LIMIT PRESSURE SWITCHES SHALL REQUIRE MANUAL RESET AT THEIR RESPECTIVE UNIT. EMERGENCY FAN SHUTDOWN SHALL BE RESET WHEN THE EMERGENCY POWER OFF SWITCH IS RESET. SMOKE DETECTOR TRIPPING SHALL BE RESET WHEN THE ALARM IS NO LONGER PRESENT IN THE FIRE ALARM SYSTEM.
- PROVIDE AN UNINTERRUPTIBLE POWER SUPPLY (UPS) FOR ALL SERVER-LEVEL BAS COMPONENTS.



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PROJECT

HOWARD COUNTY PUBLIC SCHOOLS

CAFETERIA HVAC UNIT CONVERSIONS

CONSTRUCTION DOCUMENTS  
05/25/2023

SEAL

PROFESSIONAL CERTIFICATION: I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

LICENSE NO: 37247

EXPIRATION DATE: 01/09/2024

NO.	DESCRIPTION	DATE
△	ADDENDUM NO. 2	6/14/2023

KEY PLAN

AUTOMATIC CONTROLS

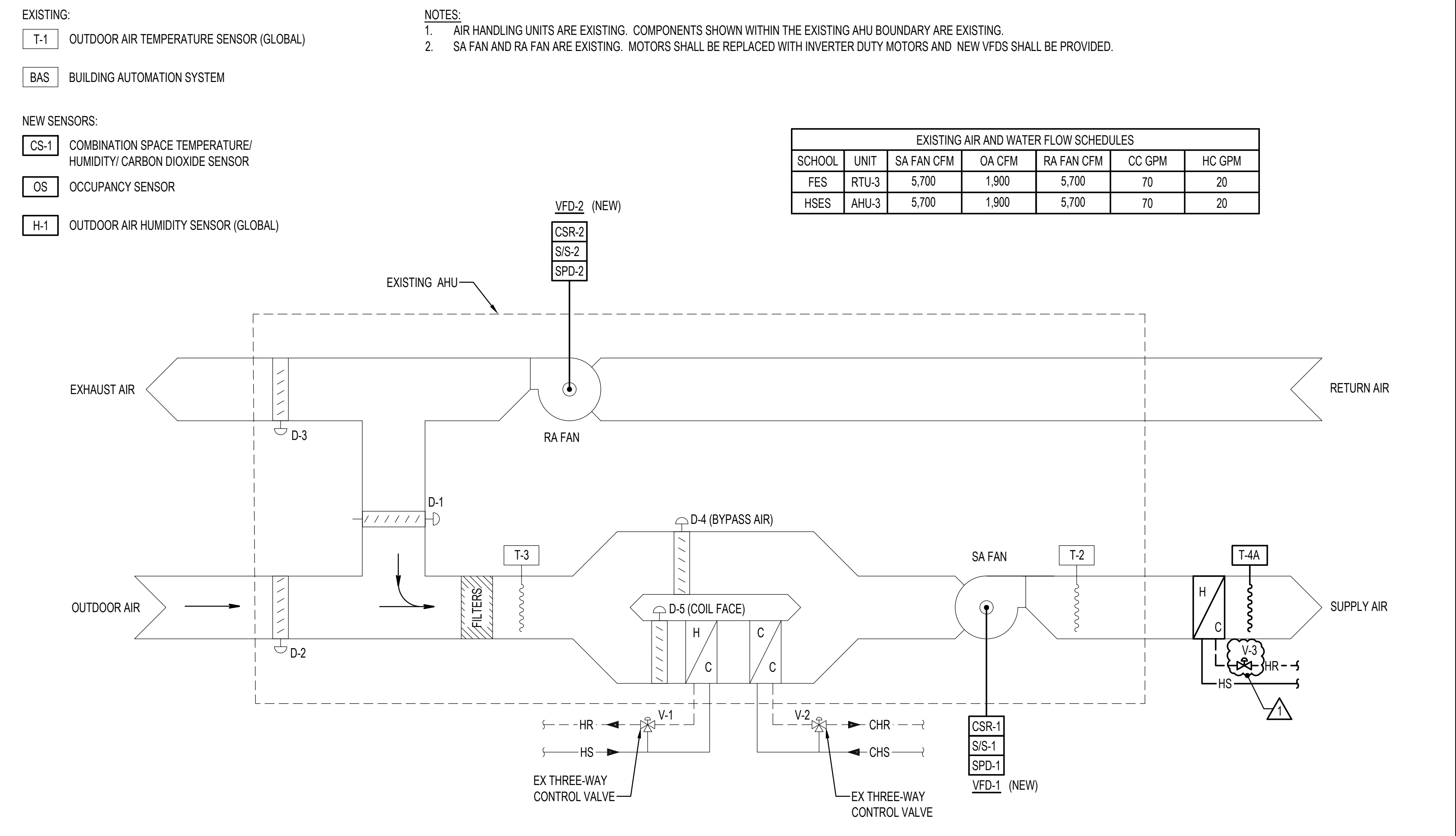
PROJECT NUMBER PC-10028674

DATE 05/25/2023

DRAWN BY BMB

CHECKED BY SRH

M701



EXISTING AIR AND WATER FLOW SCHEDULES						
SCHOOL	UNIT	SA FAN CFM	OA CFM	RA FAN CFM	CC GPM	HC GPM
FES	RTU-3	5,700	1,900	5,700	70	20
HSES	AHU-3	5,700	1,900	5,700	70	20

**CONTROL DIAGRAM FOR VARIABLE VOLUME AIR HANDLING UNIT AT:  
FULTON ELEMENTARY SCHOOL (RTU-3)  
HOLLIFIELD STATION ELEMENTARY SCHOOL (AHU-3)**

DDC POINT LIST				
FULTON ELEMENTARY SCHOOL (RTU-3)				
HOLLIFIELD STATION ELEMENTARY SCHOOL (AHU-3)				
POINT TYPE	TAG	DESCRIPTION	FUNCTIONS	NEW/EXISTING
ANALOG INPUT	T-1	OUTDOOR TEMPERATURE	TREND	EXISTING
	H-1	OUTDOOR RELATIVE HUMIDITY	TREND	NEW
	H-2	SPACE RELATIVE HUMIDITY	TREND	NEW
	CO2-2	SPACE CO2 CONCENTRATION	TREND	NEW
	T-5	SPACE TEMPERATURE	TREND	NEW
	T-2	SUPPLY LEAVING TEMPERATURE	TREND	EXISTING
DIGITAL INPUT	T-3	MIXED AIR TEMPERATURE	TREND	EXISTING
	T-4A	RHC TEMPERATURE - DOWNSTREAM	TREND	NEW
	SF-1	SUPPLY FAN STATUS	ALARM	EXISTING
	RF-1	RETURN FAN STATUS	ALARM	EXISTING
	LT-1	LOW LIMIT TEMPERATURE	ALARM	EXISTING
ANALOG OUTPUT	CSR-1	SUPPLY FAN STATUS	ALARM	NEW
	CSR-2	RETURN FAN STATUS	ALARM	NEW
	OS	SPACE OCCUPANCY	TREND	NEW
	SPD-1	SUPPLY FAN SPEED (VFD-1)	TREND	NEW
	SPD-2	RETURN FAN SPEED (VFD-2)	TREND	NEW
	V-1	HEATING COIL VALVE	TREND	EXISTING
	V-2	COOLING COIL VALVE	TREND	EXISTING
	V-3	REHEAT COIL VALVE	TREND	NEW
	D-1	RETURN AIR DAMPER	TREND	EXISTING
	D-2	OUTDOOR AIR DAMPER	TREND	EXISTING
DIGITAL OUTPUT	D-3	RELIEF AIR DAMPER	TREND	EXISTING
	D-4	BYPASS AIR DAMPER	TREND	EXISTING
	D-5	COIL FACE DAMPER	TREND	EXISTING
	S/S-1	SUPPLY FAN START/STOP (VFD-1)	TREND	NEW
	S/S-2	RETURN FAN START/STOP (VFD-2)	TREND	NEW

**INPUT/OUTPUT SUMMARY FOR:  
FULTON ELEMENTARY SCHOOL (RTU-3)  
HOLLIFIELD STATION ELEMENTARY SCHOOL (AHU-3)**

- GENERAL:**
- ALL GENERAL FUNCTIONS OF THE EXISTING SEQUENCE OF OPERATION, SUCH AS UNIT SCHEDULING, UNOCCUPIED OPERATION, MORNING WARM-UP/COOL-DOWN, AND SAFETIES SHALL BE THE SAME AS EXISTING.
  - COORDINATE VARIABLE FREQUENCY DRIVE (VFD) INTERFACE REQUIREMENTS WITH VFD MANUFACTURER.

- STARTING AND STOPPING:**
- WHEN THE UNIT SUPPLY AIR FAN AND RETURN AIR FAN ARE ENERGIZED TO OPERATE, THE FANS SHALL BE SOFT STARTED THROUGH THEIR ASSOCIATED VARIABLE FREQUENCY DRIVES.
- SUPPLY FAN AND RETURN FAN CONTROL:**  
THE VARIABLE SPEED SUPPLY FAN AND RETURN FAN WILL BE STARTED BASED ON OCCUPANCY SCHEDULE. WHEN THE SUPPLY FAN AND RETURN FAN STATUS INDICATES THE FANS HAVE STARTED, THE CONTROL SEQUENCE SHALL BE ENABLED.

- OCCUPIED HEATING MODE:**
- WHEN HEATING IS REQUIRED, BYPASS DAMPER D-4 SHALL BE CLOSED AND COIL FACE DAMPER D-5 SHALL BE FULLY OPENED.
  - THE OUTDOOR AIR AND RELIEF AIR DAMPERS SHALL BE AT THEIR MINIMUM POSITIONS, AND THE RETURN AIR DAMPER SHALL BE AT ITS MAXIMUM POSITION. THE SUPPLY AND RETURN FANS SHALL BE AT THEIR MAXIMUM SPEED DELIVERING THE DESIGN SUPPLY AND RETURN AIR FLOWS (AS DETERMINED DURING AIR BALANCING OF THE UNIT). THE SPACE TEMPERATURE SENSOR SHALL MODULATE THE HVAC UNIT'S HEATING WATER COIL CONTROL VALVE TO MAINTAIN THE OCCUPIED SPACE HEATING SETPOINT (70°F). THE REHEAT COIL VALVE SHALL BE CLOSED.
  - DEHUMIDIFICATION MODE:
    - IF, DURING THE OCCUPIED HEATING MODE OF OPERATION, THE SPACE RELATIVE HUMIDITY RISES ABOVE 60%, THE SPACE HEATING SETPOINT SHALL BE RESET TO 73°F.
    - IF, AFTER A 30-MINUTE TIME DELAY, THE SPACE RELATIVE HUMIDITY REMAINS ABOVE 60%, THE FOLLOWING SHALL OCCUR:
      - IF CHILLED WATER, ENTHALPY ECONOMIZER, OR FREE COOLING ARE AVAILABLE, THE UNIT SHALL CHANGE ITS MODE OF OPERATION TO OCCUPIED COOLING WITH A SPACE COOLING SETPOINT OF 73°F UNTIL THE SPACE RELATIVE HUMIDITY DROPS BELOW 50%. UPON A DROP IN SPACE RELATIVE HUMIDITY BELOW 50%, THE UNIT SHALL REVERT TO THE OCCUPIED HEATING MODE WITH THE NORMAL SPACE HEATING SETPOINT OF 70°F.
      - IF CHILLED WATER, ENTHALPY ECONOMIZER, OR FREE COOLING ARE NOT AVAILABLE, THE UNIT SHALL REMAIN IN THE OCCUPIED HEATING MODE AND THE SPACE HEATING SETPOINT SHALL REMAIN AT 73°F UNTIL THE SPACE RELATIVE HUMIDITY DROPS BELOW 50%. UPON A DROP IN SPACE RELATIVE HUMIDITY BELOW 50%, THE SPACE HEATING SETPOINT SHALL BE RESET TO 70°F.

- OCCUPIED COOLING MODE:**
- DISCHARGE AIR TEMPERATURE CONTROL:
    - WHEN MECHANICAL COOLING IS REQUIRED, THE CHILLED WATER CONTROL VALVE V-2 SHALL BE FULLY OPEN TO THE COOLING COIL.
  - MINIMUM OUTDOOR AIR MODE: THE OUTDOOR AIR AND RELIEF AIR DAMPERS SHALL BE AT THEIR MINIMUM POSITIONS, AND THE RETURN AIR DAMPER SHALL BE AT ITS MAXIMUM POSITION. THE COIL FACE DAMPER, D-5, AND BYPASS DAMPER, D-4, SHALL MODULATE TO MAINTAIN A 55°F DISCHARGE AIR TEMPERATURE.
  - ENTHALPY ECONOMIZER MODE: WHEN THE OUTDOOR AIR ENTHALPY IS LESS THAN THE RETURN AIR ENTHALPY AND CONTINUES WITH A DEADBAND OF 3 BTU/LB OR UNTIL THE OUTDOOR AIR TEMPERATURE RISES ABOVE 80°F, THE OUTDOOR AIR AND RELIEF AIR DAMPERS SHALL BE FULLY OPENED AND THE RETURN AIR DAMPER SHALL BE FULLY CLOSED. THE COIL FACE DAMPER, D-5, AND BYPASS DAMPER, D-4, SHALL MODULATE TO MAINTAIN A 55°F DISCHARGE AIR TEMPERATURE.
  - FREE COOLING MODE: WHEN THE OUTDOOR AIR TEMPERATURE IS MORE THAN 5°F BELOW THE DISCHARGE AIR TEMPERATURE SETPOINT, MECHANICAL COOLING SHALL BE LOCKED OUT AND THE OUTDOOR AIR, RELIEF AIR, AND RETURN AIR DAMPERS SHALL MODULATE TO MAINTAIN A 55°F DISCHARGE AIR TEMPERATURE.
  - FAN SPEED CONTROL:
    - THE SUPPLY FAN VFD SHALL MODULATE THE SUPPLY FAN SPEED TO MAINTAIN THE OCCUPIED SPACE COOLING SETPOINT (76°F). THE RETURN FAN VFD SHALL MODULATE THE RETURN FAN SPEED TO LAG THE SUPPLY FAN SPEED BY AN ADJUSTABLE PERCENTAGE DIFFERENTIAL. WHEN THE SUPPLY FAN IS AT ITS MINIMUM 50% SPEED, UPON A FURTHER DROP IN SPACE TEMPERATURE BELOW THE COOLING SETPOINT, THE REHEAT COIL CONTROL VALVE SHALL MODULATE OPEN TO MAINTAIN THE SPACE COOLING SETPOINT.

- REDUCED OCCUPANCY MODE:**
- WHEN ALL OCCUPANCY SENSORS INDICATE A LACK OF OCCUPANCY IN THE CAFETERIA, THE OUTDOOR AIR AND RELIEF AIR DAMPERS SHALL CLOSE, THE RETURN AIR DAMPER SHALL OPEN, AND THE SUPPLY AND RETURN AIR FAN PERCENTAGE DIFFERENTIAL SHALL BE SET TO ZERO. THE UNIT SHALL REVERT TO ITS NORMAL MODE OF OPERATION ONCE OCCUPANCY IS DETECTED CONTINUOUSLY BY ANY OCCUPANCY SENSOR FOR 5 MINUTES.

- DEMAND-CONTROLLED VENTILATION (DCV):**
- UPON A RISE IN SPACE CO<sub>2</sub> CONCENTRATION ABOVE 1,000 PPM, THE OUTDOOR AIR AND RELIEF AIR DAMPERS SHALL MODULATE OPEN AND THE RETURN AIR DAMPER SHALL MODULATE CLOSED TO MAINTAIN THE 1,000 PPM CO<sub>2</sub> SETPOINT. UPON A DROP IN SPACE CO<sub>2</sub> CONCENTRATION BELOW 800 PPM, THE UNIT SHALL REVERT TO NORMAL OPERATION.

- UNOCCUPIED DEHUMIDIFICATION MODE:**
- IF, AFTER A 4-HOUR TIME DELAY, THE SPACE RELATIVE HUMIDITY REMAINS ABOVE 60% DURING THE UNOCCUPIED MODE OF OPERATION, THE UNIT SHALL BE ENERGIZED, THE HEATING WATER PLANT SHALL BE ENABLED, THE CHILLED WATER PLANT SHALL BE ENABLED IF FREE COOLING IS NOT AVAILABLE, AND THE UNIT SHALL OPERATE WITH THE OUTDOOR AIR AND RELIEF AIR DAMPERS CLOSED, THE RETURN AIR DAMPER OPENED, AND THE SUPPLY AND RETURN AIR FAN PERCENTAGE DIFFERENTIAL SET TO ZERO TO MAINTAIN THE UNOCCUPIED SPACE COOLING SETPOINT (82°F) UNTIL THE SPACE RELATIVE HUMIDITY DROPS BELOW 50%.

- EXHAUST FAN CONTROL:**
- INTERLOCKED EXHAUST FANS SHALL BE THE SAME AS EXISTING.

**SEQUENCE OF OPERATION FOR:  
FULTON ELEMENTARY SCHOOL (RTU-3)  
HOLLIFIELD STATION ELEMENTARY SCHOOL (AHU-3)**







