



# KANSAS CITY KANSAS PUBLIC SCHOOLS / USD 500

PURCHASING OFFICE | 2010 N. 59<sup>TH</sup> STREET | ROOM 370 \ KANSAS CITY, KS 66104

WEB SITE: [WWW.KCKPS.ORG/PURCHASING](http://WWW.KCKPS.ORG/PURCHASING)

## MECHANICAL UPGRADES FOR EISENHOWER MIDDLE SCHOOL AND FL SCHLAGLE HIGH SCHOOL

**BID NO:** **IFB 22-007**      **ISSUE DATE:** **MARCH 9, 2022**

Purchasing Office, 2010 N. 59<sup>th</sup> Street, Room 370, Kansas City, KS 66104 until **2:00 PM., March 22, 2022**, at which time bids received will be publicly opened and read, for providing:

**Automatic Temperature Controls (ATC), Variable Air Volume (VAV) box, and associated Heating, Ventilation and Air Conditioning (HVAC) component replacement for**

**Eisenhower Middle School**

2901 N 72<sup>nd</sup> Street  
Kansas City, KS 66109

**FL Schlagle High School**

2214 N. 59<sup>th</sup> Street  
Kansas City, KS 66104

In accordance with bid instructions, specifications and/or bid conditions attached hereto or as shown below.

**PRE-BID CONFERENCE (Non-Mandatory)**

**Date:** March 16, 2022

**Time:** 10:00 AM

**Location:** Facilities Department  
North Central Office  
2220 N. 59th Street  
Suite 229  
Kansas City, KS 66104

**Information:** At which time a pre-bid meeting will be held. Pre-bid meeting is non-mandatory.

**Contact/Technical Contact:**

Wayne C. Correll, Director of Purchasing | (913) 279-2270 | e-Mail: [wayne.correll@kckps.org](mailto:wayne.correll@kckps.org)

**INSTRUCTIONS:**

FAXED BIDS WILL NOT BE ACCEPTED / EMAILED BIDS WILL NOT BE ACCEPTED.

**Per attached specifications listed in this invitation to bid. Bidders must specify manufacturer/model number/delivery days, and unit price on each item or bid may be**

**determined to be non-responsive.**

- Bids will only be accepted for those brands that have been shown on the attached equipment schedule. Because this is a direct unit replacement (which eliminates the need for extensive electrical and gas plumbing renovation), not substitutions will be accepted.
- Pricing shall be FOB Kansas City, KS (freight and fuel expenses included).
- Award will be to ONE vendor.
- The District reserves the right to reject any or all bids, to waive any informalities, irregularities, or technical defects in bids, and unless otherwise specified by the District to accept any item or groups of items in the bid, as may be in the best interest of the District.
- Time (days, weeks, etc.) required for delivery is a significant consideration with respect to this award process. The time required for delivery must be indicated in the space provided or your bid may be found non-responsive and may not be considered.
- Bid shall include copies of pertinent warranty information pertaining to the product offered. The bidder agrees that equipment furnished under any resultant purchase order issued by Kansas City Kansas Public Schools shall be covered by commercial warranties the contractor gives to any customer for such supplies. All warranty information and certificates shall be furnished and become the property of the District upon delivery and acceptance of said items and/or the contractor must honor services and all rights and remedies stated in the warranties.
- All items are new manufacture unless otherwise specifically stated in this bid.
- All products must have passed the first line quality standard as set by the manufacturer and no seconds, blemished articles or items having defective workmanship are included.
- Bidder shall notify the District immediately of any changes to specifications made by the manufacturer for the equipment listed.
- Bid may not be considered if a service charge, minimum dollar, or minimum quantity order is applied.
- Bidder shall acknowledge all addenda for this bid and include the form acknowledgments with their bid.

**INCLEMENT WEATHER OR EMERGENCY**

**IF THERE IS A BUILDING CLOSING THE DAY OF THE OPENING OF PROPOSALS DUE TO INCLEMENT WEATHER OR AN EMERGENCY, THE OPENING OF PROPOSALS WILL OCCUR AT 2:00PM (CENTRAL) THE NEXT BUSINESS DAY THE DISTRICT IS OPEN.**

Reference Attachment A for further Bid Conditions and Instructions

## KANSAS CITY KANSAS PUBLIC SCHOOLS

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### Instructions to Bidders

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1. BIDDER REPRESENTATION:

Each bidder by making his bid represents that:

- 1.1 Bidder has read and understands the Bidding Documents, and its Bid is made in accordance therewith. By submitting a Bid, the Bidder acknowledges that it has read this solicitation, understands it, and agrees to be bound by its terms and conditions.
- 1.2 Bidder has visited and examined the site, has compared it with the plans and specifications, and has familiarized and satisfied itself with the local conditions under which the work is to be performed, and therefore assumes responsibility for estimating properly the difficulties and cost of successfully performing the Work.
- 1.3 Bidder's Bid is based upon the materials, systems, and equipment described in the Bidding documents without exceptions.
- 1.4 That Bidder is financially solvent and that it is experienced in and competent to perform the type of work as specified.
- 1.5 That Bidder is familiar with all Federal, State, and Municipal laws, ordinances, and regulations, which may in any way affect the work.
- 1.6 That failure of omission of any bidder to do any of the foregoing shall in no way relieve the Bidder from any obligation in respect to his Bid Proposal.

2. PREPARATION AND SUBMISSION OF BID PROPOSAL:

- 2.1 Bidders are required to use the Bid form enclosed in the Bidding Documents.
- 2.2 The proposal shall not be modified or conditioned in any manner.
- 2.3 All blank spaces must be filled in, in ink or typewritten, and the Bid Proposal must be fully completed and executed when submitted. No alterations in the Bid Proposal or in the printed forms by erasures or deletions will be acceptable unless each alteration is initialed by the Bidder.
- 2.4 All names must be typed or printed below the signature.
- 2.5 The Bid shall contain an acknowledgment of receipt of all Addenda.
- 2.6 All copies of the Bid, the Bid Bond, and any other documents required to be submitted with Bid shall be enclosed in a sealed opaque envelope, marked "*Bid for Mechanical Upgrades for Eisenhower MS & FL Schlagle HS*".
- 2.7 The envelope containing the Bid Proposal should bear on the outside the name of the Bidder, Bidder's address, project name, date, and time of Bid opening. If a Bid is submitted by mail or express mail, this aforementioned sealed envelope should be enclosed in an outer envelope and sent to the following address: The outer envelope shall be marked "Bid Enclosed".

Kansas City Kansas Public Schools  
Attn: Director of Purchasing  
2010 N. 59<sup>th</sup> Street, Room 370  
Kansas City, Kansas 66104

- 2.8 Each copy shall include the legal name of Bidder and shall be signed by the person or persons legally authorized to bind the Bidder to the Contract. A Bid by a corporation shall have the corporate seal affixed. A Bid submitted by agent shall have a current Power of Attorney attached certifying the agent's authority to bind the Bidder.
- 2.9 Bid shall include a list of all proposed subcontractors and suppliers of major items of material and equipment.
- 2.10 Where so indicated by the makeup of the Bid Form, sums shall be expressed in both words and figures

and in case of discrepancy between the two, the written amount shall govern.

- 2.11 In case of an error in the extension of a price in the Bid, the unit price will govern.
- 2.12 All requested alternates shall be bid.
- 2.13 Bidders shall make no additional stipulation or voluntary alternates on the Bid Form or in separate envelopes, nor qualify his Bid in any other manner.
- 2.14 Bidder shall assume full responsibility for timely delivery at location designated for receipt of Bids. A bid is invalid if it has not been deposited at the designated location prior to the time and date for receipt of Bids stated herein or in the Invitation to Bid, or any extension thereof issued to the Bidders.

3. RECEIPT AND OPENING OF BIDS:

- 3.1 Bids will be received by Kansas City Kansas Public Schools, Kansas City, Kansas (herein called KCKPS or Owner) at the time and place stated in the Advertisement and Invitation for Bids and the publicly opened and read aloud.
- 3.2 All Bids will remain subject to acceptance for forty-five (45) days after the day of the Bid opening, but KCKPS may, in its sole discretion, release any Bid and return the Bid security prior to that date.

4. CONSIDERATION AND AWARDING OF BIDS:

- 4.1 Qualifications of Contractors:
  - 4.1.1 Only qualified mechanical contractors with experience and expertise in installing and utilizing equipment and controls are eligible to submit bids for this project.
  - 4.1.2 Tours of the facility are available upon request. Contact Steve Knight with KCKPS Facilities Department at (913) 627-3850.
  - 4.1.3 [Omitted Intentionally]
  - 4.1.4 Submission of Qualification Statement: If the Owner desires the bidders to whom award of a contract is under consideration shall submit to the Owner, Architect or Engineer, upon his request, a properly executed Contractor's Qualification Statement, AIA Document A305 unless such statement has been previously required and submitted as a prerequisite to the issuance of Bidding Documents.
  - 4.1.5 Proximity to Kansas City, KS: Due to the nature of this project and the probability that new temperature controls in this project will require adjustments and warranty corrections, contractors submitting bids must be able to respond to service or warranty calls within 8 hours and must be no further than 200 miles away from Kansas City, KS. Actual distance will be based on street address to street address via GoogleMaps. Bidders shall list the business address, and phone number of the office that will respond to service or warranty calls on the Bid Form.
- 4.2 Qualifications of Subcontractors:
  - 4.2.1 The Bidder may be required to establish to the satisfaction of the Owner the reliability and responsibility of the proposed Subcontractors to furnish and perform the work described in the Sections of the Specifications pertaining to such proposed Subcontractors' respective trades.
  - 4.2.2 If the Owner or Engineer has objection to any person or organization on such list, and refused in writing to accept such person or organization, The Bidder may, at his option, (a) withdraw his Bid, or (b) submit an acceptable Subcontractor.
- 4.3 Awarding of the Bid
  - 4.3.1 Kansas City Kansas Public Schools shall have the right to reject any or all Bids, for any reason. Specifically, but without limitation, Kansas City Kansas Public Schools shall have the right to reject a Bid not accompanied by Bid security in the proper form and amount, or a Bid not accompanied by data required by the Bidding Documents, or a Bid which is in any way incomplete, irregular, or unresponsive.
  - 4.3.2 The Owner may make such investigations as he deems necessary to determine the ability of the Bidder to perform the Work, and the Bidder shall furnish to the Owner all such information and

data for this purpose as the Owner may request. The Owner reserves the right to reject any bid, if the evidence submitted by, or the investigation of, such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligations of the Contract and to complete the work contemplated therein.

- 4.3.3 The Owner further reserves the right to accept or reject any bid on any section or all sections of the Specifications; to waive any irregularities or informalities in any bid received; and to award contracts in the best interest of the Owner.

5. MODIFICATION AND WITHDRAWAL OF BID PROPOSAL:

- 5.1 Any Bid Proposal may be withdrawn prior to the scheduled time for the opening of the Bids.
- 5.2 Any Bid Proposal can be modified by facsimile or email communication, providing such communication is received by the KCKPS prior to the actual time of the Bid opening. The changes to the Bid must be in writing and submitted in a sealed envelope.
- 5.3 A Bid may not be modified, withdrawn or canceled by the Bidder for a period of 45 days following the time and date designated for the receipt of Bids, and Bidder so agrees in submitting the Bid.

6. ADDENDA, INTERPRETATION, OR CORRECTION OF BIDDING DOCUMENTS:

- 6.1 Each Bidder shall examine the bidding Document carefully and no later than five (5) days prior to the date of receipt of Bids shall make a written or verbal request to the Engineer: Pearson Kent McKinley Raaf Engineers LLC, 13300 W 98th Street, Lenexa, KS 66215, PHONE 913-492-2400, EMAIL [admin@pkmreng.com](mailto:admin@pkmreng.com) for interpretation or correction of ambiguity, inconsistency, or error therein which he may discover. Any interpretation or correction by Addendum will be binding. No Bidder shall rely upon interpretation or correction given by any other methods.
- 6.2 Prior to receipt of Bids, any Addenda will post to the website where construction documents were obtained.
- 6.3 Bidders shall acknowledge receipt of all Addenda which have been issued during the period of Bidding and agree that said Addenda shall become a part of this contract. Bidder shall list the numbers and issuing dates of Addenda received.
- 6.4 No Addenda will be issued later than two days prior to the date for receipt of bids except an Addendum withdrawing the request for Bids or one which includes postponement for the date for receipt of Bids. Addenda are considered issued when posted.
- 6.5 Kansas City Kansas Public Schools representative for this project is stated below, please direct any questions to: Wayne Correll, Director of Purchasing [wayne.correll@kckps.org](mailto:wayne.correll@kckps.org)

7. BID SECURITY:

- 7.1 Each Bid must be accompanied by a Bid Bond payable to KCKPS Treasurer BOE for five percent (5%) of the total amount of the Base Bid, (a certified check may be used in lieu of a Bid Bond) pledging that the Bidder will enter into a contract with Kansas City Kansas Public Schools on the terms stated in his Bid.
- 7.2 Kansas City Kansas Public Schools will have the right to retain the bid security of the Bidders until
- the Contract has been executed and bonds, as required, have been furnished, or
  - the specified time has elapsed so the Bids may be withdrawn, or
  - all Bids have been rejected.
- 7.3 Should the Bidder refuse to enter into such a Contract or fail to furnish the required bonds, the amount of the bid security shall be forfeited to Kansas City Kansas Public Schools as liquidated damages, and not as a penalty.
- 7.4 The Bid Security of other Bidders will be retained for a period of thirty (30) days after the Bid opening.
- 7.5 The Bid Security must clearly make reference to the Bid.

8. CONTRACT SECURITY:

- 8.1 A Performance Payment Bond is required. The Bond shall be in the amount of 100 percent (100%) of the contract price, with an approved corporate surety, will be required for the faithful performance of the

contract, prior to contract execution.

- 8.2 Performance and Payment Bond shall be furnished within ten (10) calendar days from the date of the Notice of Award.

9. POWER OF ATTORNEY:

- 9.1 Attorneys-in-fact who executed the bond on behalf of the surety shall affix a certified and current copy of his Power of Attorney.

10. CONTRACT DOCUMENTS:

- 10.1 The Contract Documents consisting of the Bid Documents, which include the Advertisement for Bids, Information for Bidders, Special Conditions, General Conditions, Addendum, Bid Bond, Bid Proposal, Bid Schedule, and Project Drawings.

11. NOTICE OF AWARD AND FAILURE TO ENTER CONTRACT:

- 11.1 A Notice of Award will be issued to the lowest responsible bidder.
- 11.2 The party to whom the contract is to be awarded will be required to obtain Certificates of Insurance and a Performance and Payment Bond, as contract security, within ten (10) calendar days from the date the Notice of Award is delivered to the Bidder.
- 11.3 In case of failure of the Bidder to execute the Contract of Agreement and provide satisfactory Insurance and Contract Security, KCKPS may at their option consider the Bidder in default, in which the Bid Bond accompanying the Proposal shall become property of the KCKPS.
- 11.4 If the Bidder to whom the Contract shall have been awarded fails, refuses or neglects to return the Contract, bonds and insurance certificate, Kansas City Kansas Public Schools reserves the right to retain the Bid Bond as liquidated damages or take such action as it deems appropriate including legal action for damages or specific performance.

12. NOTICE TO PROCEED:

- 12.1 KCKPS will issue a Notice to Proceed when all administrative requirements are completed and approved. The Contractor shall not begin work until the Notice to Proceed is issued.

13. QUALIFICATIONS OF BIDDERS:

- 13.1 KCKPS may make such investigation as it deems necessary to determine the ability of the Bidder to perform the work and the Bidder shall furnish to KCKPS all such information and data for this purpose as KCKPS may request.
- 13.2 KCKPS reserves the right to accept or reject any Bid or all Bids; and reserves the right to let the Bid in any manner it sees fit.

14. SUBSTITUTIONS:

- 14.1 The materials, products, and equipment described in the Bidding Documents establish a standard or required function, dimension, appearance, and quality which must be met by any proposed substitution.
- 14.2 No substitution will be considered unless written request for approval has been submitted by the Bidder to the Engineer no later than the issuance of the last addendum. Each request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data, and any other information necessary for an evaluation. A statement setting forth any changes in other materials, equipment, or work that incorporation of the substitute is the responsibility of the proposer. The Engineer's decision of approval or disapproval of a proposed substitution shall be final.
- 14.3 If the Engineer approves any proposed substitution, such approval will be set forth in Addendum. Bidder shall not rely upon approvals made in any other manner.

15. INSURANCE:

- 15.1 The successful Bidder will be required to purchase at his own expense and maintain during the life of the contract, Comprehensive General Liability, Comprehensive Automobile and Worker's Compensation with limits of not less than those set forth below.
- 15.2 The Bidder shall deliver the required Certificate of Insurance prior to the date of execution of the Contract.
- 15.3 Contractor shall procure and maintain at his cost and expense, during the entire period of the contract (including any applicable warranty and/or renewal periods) the types of insurance specified below. All insurance shall be procured from reputable insurers authorized to do business in the State of Wyoming. General Liability - Commercial Bodily Injury \$1,000,000 each occurrence \$1,000,000 aggregate Property Damage \$1,000,000 each occurrence \$1,000,000 aggregate Automobile Liability (Hired & Non-Owned Auto) Combined Single Limits (CSL) \$1,000,000 Workmen's Compensation As required by law.
- 15.4 The policy shall name Kansas City Kansas Public Schools / USD No. 500 as a named insured and shall contain a provision that the policy may not be canceled, terminated, or modified without a 30-day written notice.
- 15.5 The Contractor shall not commence work on the site until he has obtained all insurance required under the contract nor shall he allow any subcontractor to commence work until all similar insurance required of the subcontractor has been obtained.
- 15.6 The providing of any insurance required herein does not relieve the Bidder of any of the responsibilities or obligations assumed by the Bidder in the Contract awarded, or for which the Bidder may be liable by law or otherwise.

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## SECTION 230010 – MECHANICAL PROVISIONS

### PART 1 - GENERAL

#### 1.1. RELATED DOCUMENTS

- A. All contract documents including drawings, alternates, addenda and modifications and general provisions of the Contract, including General and Supplementary Conditions and all other Division Specification Sections, apply to work of this section. All preceding and following sections of this specification division are applicable to the Mechanical Contractor, all sub-contractors, and all material suppliers.

#### 1.2. SCOPE OF WORK

- A. This DIVISION requires the furnishing and installing of complete functioning Mechanical systems, and each element thereof, as specified or indicated on Drawings or reasonably inferred, including every article, device or accessory reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. In case of an inconsistency between the Drawings and Specifications or within either document, the better quality or the greater quantity of work shall be provided in accordance with the Architect or Engineer's interpretation.
- C. Refer to Architectural, Structural and Electrical Drawings and all other contract documents and to relevant equipment drawings and shop drawings to determine the extent of clear spaces and make all offsets required to clear equipment, beams and other structural members to facilitate concealing piping and ductwork in the manner anticipated in the design.

#### 1.3. SPECIFICATION FORM AND DEFINITIONS

- A. The Engineer indicated in these specifications is Pearson Kent McKinley Raaf Engineers LLC. 13300 W 98th Street, Lenexa, KS 66215, PHONE 913-492-2400, EMAIL admin@pkmreng.com.
- B. Contractor, wherever used in these specifications, shall mean the Company that enters into contract with the Owner to perform this section of work.
- C. When a word, such as "proper", "satisfactory", "equivalent", and "as directed", is used, it requires the Architect-Engineer's review.
- D. "PROVIDE" means to supply, purchase, transport, place, erect, connect, test, and turn over to Owner, complete and ready for regular operation, the particular Work referred to.
- E. "INSTALL" means to join, unite, fasten, link, attach, set up, or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation, the particular Work referred to.
- F. "FURNISH" means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application for the particular Work referred to.
- G. "WIRING" means the inclusion of all raceways, fittings, conductors, connectors, tape, junction and outlet boxes, connections, splices, and all other items necessary and/or required in connection with such Work.
- H. "CONDUIT" means the inclusion of all fittings, hangers, supports, sleeves, etc.
- I. "AS DIRECTED" means as directed by the Architect/Engineer, or his representative.
- J. "CONCEALED" means embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed above hung ceilings.

#### 1.4. QUALIFICATIONS

- A. The contractors responsible for work under this section shall have completed a job of similar scope and magnitude within the last 3 years. The contractors shall employ an experienced, competent and adequate work force licensed in their specific trade and properly supervised at all times. Unlicensed workers and general laborers shall be adequately supervised to insure competent and quality work and workmanship required by this contract and all other regulations, codes and practices. At all times the contractors shall comply with all applicable local, state and federal guidelines, practices and regulations. Contractor may be required to submit a statement of qualifications upon request before any final approval and selection. Failure to be able to comply with these requirements is suitable reason for rejection of a bid.

#### 1.5. LOCAL CONDITIONS

- A. The contractor shall visit the site and determine the existing local conditions affecting the work required. Failure to determine site conditions or nature of existing or new construction will not be considered a basis for granting additional compensation.

#### 1.6. CONTRACT CHANGES

- A. Changes or deviations from the contract documents; including those for extra or additional work must be submitted in writing for review of Architect-Engineer. No verbal change orders will be recognized.

#### 1.7. LOCATIONS AND INTERFERENCES

- A. Locations of equipment, piping and other mechanical work are indicated diagrammatically by the mechanical drawings. The Contractor shall determine the exact locations on site, subject to structural conditions, work of other Contractors, and access requirements for installation and maintenance to approval of Architect-Engineer. Provide additional piping and ductwork offsets as required at no additional cost.
- B. Study and become familiar with the contract drawings of other trades and in particular the general construction plans and details in order to obtain necessary information for figuring installation. Cooperate with other contractors and install work in such a way as to avoid interference with their work. Minor deviations, not affecting design characteristics, performance or space limitation may be permitted if reviewed prior to installation by Architect-Engineer.
- C. Any pipe, ductwork, equipment, apparatus, appliance or other item interfering with proper placement of other work as indicated on drawings, specified, or required, shall be removed, relocated and reconnected without extra cost. Damage to other work caused by this Contractor, the Subcontractor, or workers shall be restored as specified for new work.
- D. Do not scale mechanical and electrical drawings for dimensions. Contractor shall accurately layout work from the dimensions indicated on the Architectural drawings unless they are found to be in error.

#### 1.8. PERFORMANCE

- A. Final acceptance of work shall be subject to the condition that all systems, equipment, apparatus and appliances operate satisfactorily as designed and intended. Work shall include required adjustment of systems and control equipment installed under this specification division.
- B. The Contractor warrants to the Owner and Architect-Engineer the quality of materials, equipment, workmanship and operation of equipment provided under this specification division for a period of one year from and after completion of building and acceptance of mechanical systems by Owner.

#### 1.9. WARRANTY

- A. The Contractor warrants to the Owner and Architect-Engineer that upon notice from them within a one year warranty period following date of acceptance, that all defects that have appeared in materials and/or workmanship, will be promptly corrected to original condition required by contract documents at Contractor's expense.
- B. Warranty for all equipment shall take effect from the date of substantial completion regardless of the date equipment was installed.
- C. The above warranty shall not supersede any separately stated warranty or other requirements required by law or by these specifications.

#### 1.10. ALTERNATES

- A. Refer to General Requirements for descriptions of any alternates that may be included.

#### 1.11. MATERIALS, EQUIPMENT AND SUBSTITUTIONS

- A. The intent of these specifications is to allow ample opportunity for Contractor to use his ingenuity and abilities to perform the work to his and the Owner's best advantage, and to permit maximum competition in bidding on standards of materials and equipment required.
- B. Material and equipment installed under this contract shall be first class quality, new, unused and without damage.
- C. In general, these specifications identify required materials and equipment by naming one or more manufacturer's brand, model, catalog number and/or other identification. The first named manufacturer or product is used as the basis for design; other manufacturers named must furnish products consistent with specifications of first named product as determined by Engineer. Base bid proposal shall be based only on materials and equipment by manufacturers named, except as hereinafter provided.
- D. Where materials or equipment are described but not named, provide required items of first quality, adequate in every respect for intended use. Such items shall be submitted to Architect-Engineer for review prior to procurement.
- E. Materials and equipment proposed for substitutions shall be equal to or superior to that specified in construction, efficiency, utility, aesthetic design, and color as determined by Architect-Engineer whose decision shall be final and without further recourse. Physical size of substitute brand shall be no larger than space provided including allowances for access for installation and maintenance. Requests must be accompanied by two copies of complete descriptive and technical data including manufacturer's name, model and catalog number, photographs or cuts, physical dimensions, operating characteristics and any other information needed for comparison.
- F. If the Contractor wishes to incorporate products other than those named in the Base Bid Specifications they shall submit a request for approval of equivalency in writing no later than (10) ten calendar days prior to bid date. Substitutions after this may be refused at Engineers option. Equivalents will ONLY be considered

- approved when listed by addendum.
- G. In proposing a substitution prior to or subsequent to receipt of bids, include in such bid the cost of altering other elements of this project, including adjustments in mechanical or electrical service requirements necessary to accommodate such substitution.
  - H. Within 10 working days after bids are received, the apparent low bidder shall submit to the Architect-Engineer for approval, three copies of a list of all major items of equipment they intend to provide. Within 30 working days after award of Contract, Contractor shall submit shop drawings for equipment and materials to be incorporated in work, for Architect-Engineer review. Where 30-day limit is insufficient for preparation of detailed shop drawings on major equipment or assemblies, Contractor shall submit manufacturer's descriptive catalog data and indicate date such detailed shop drawings will be submitted along with manufacturer's certification that order was placed within 30 working day limit.

#### 1.12. ELECTRONIC PLAN FILES

- A. Electronic files of the contract documents may be available from the Engineer to successful bidders and manufacturers for a fee of \$50 per sheet, \$100 minimum and \$25 email/shipping charge. A release of liability form will be required along with payment prior to release of files.

#### 1.13. TEMPORARY USE OF PERMANENT HVAC UNITS

- A. If the Contractor elects to use permanent equipment for temporary conditioning only that permanent equipment associated with the heating system shall be allowed for use as space conditioning during the construction period. The Mechanical Contractor shall take full responsibility for all permanent equipment used for temporary conditioning during the construction period and shall provide a total of two years warranty covering all parts and labor on all permanent equipment utilized for temporary conditioning. This warranty shall cover all piping, fittings, valves, pipe and equipment insulation, pumps, boilers, chillers, condensing units, cooling towers, air handling units, exhaust and relief air fans, ductwork, ductwork insulation, diffusers, temperature controls, all electric motors, starters, disconnect switches, fuses, wire and conduit. This warranty shall cover all required maintenance on the system with the exception of filter changes, and shall start on the date shown on the final completion certificate.
- B. CAUTION: The Contractor is being warned that the Architect-Engineer will not accept dirty equipment caused by construction contamination.

#### 1.14. OPENINGS, ACCESS PANELS AND SLEEVES

- A. This Contractor shall include the installation of all boxes, access panels and sleeves for openings required to install this work, except structural openings incorporated in the structural drawings. Sleeves shall be installed for all pipes passing through structural slabs and walls. Contractor shall set and verify the location of sleeves that pass through beams, as shown on structural plans. All floor and wall penetrations shall be sealed to meet fire-rating requirements.
- B. All penetrations through interior or exterior and rated or non-rated walls and floors shall be appropriately sealed prevent entry and movement of rodents and insects. Contractor shall coordinate their work with all other trades.

#### 1.15. ARCHITECTURAL VERIFICATION AND RELATED DOCUMENTS

- A. Contractor shall consult all Architectural Drawings and specifications in their entirety incorporating and certifying all millwork, furniture, and equipment rough-in including utility characteristics such as voltage, phase, amperage, pipe sizes, duct sizes, including height, location and orientation. Shop drawings incorporating these requirements should be submitted to the Architect for approval prior to installation or rough in.

#### 1.16. EXTENT OF CONTRACT WORK

- A. Provide mechanical systems indicated on drawings, specified or reasonably implied. Provide every device and accessory necessary for proper operation and completion of mechanical systems. In no case will claims for "Extra Work" be allowed for work about which Contractor could have been informed before bids were taken.
- B. Electrical work required to install and control mechanical equipment, which is not shown on plans or specified under Division 26, shall be included in Contractor's base bid proposal. Mechanical systems and components are to be installed as a complete system, including all miscellaneous interlock (low voltage and minor line voltage power wiring such as control motors, limit switches, relays, etc), control wiring, safeties. Coordinate interlock to other systems such as fire alarm that interlock to mechanical systems and insure that provisions are made in equipment for connection of these systems. Coordinate with all other trades for specific needs and requirements based on submitted systems.
- C. Contractor shall become familiar with equipment provided by other contractors that require mechanical connections and controls.
- D. All automatic temperature control devices shall be mounted as indicated in automatic temperature control section of specifications.
- E. The cost of larger wiring, conduit, control and protective devices resulting from installation of equipment which

was not used for basis of design as outlined in specifications shall be paid for by Mechanical Contractor at no cost to Owner or Architect-Engineer.

- F. Contractor shall be responsible for providing supervision to Electrical Contractor to insure that required connections, interlocking and interconnection of mechanical and electrical equipment are made to attain intended control sequences and system operation.
- G. Furnish four complete sets of electrical wiring diagrams to Architect-Engineer to be included in the maintenance manuals and three complete sets to Electrical Contractor. Diagrams shall show factory and field wiring of components and controls. Control devices and field wiring to be provided by Electrical Contractor shall be clearly indicated by notation and drawing symbols on wiring diagrams.
- H. Contractor shall obtain complete electrical data on mechanical shop drawings and shall list this data on an approved form that shall be presented monthly or on request, to Electrical Contractor. Data shall be complete with wiring diagrams received to date and shall contain necessary data on electrical components of mechanical equipment such as HP, voltage, amperes, watts, locked rotor current to allow Electrical Contractor to order electrical equipment required in his contract.

#### 1.17. WORK NOT INCLUDED IN CONTRACT

- A. Consult Division 26 of specifications for work to be provided by Electrical Contractor in conjunction with installation of mechanical equipment.

#### 1.18. CODES, RULES AND REGULATIONS

- A. Provide Work in accordance with applicable codes, rules and regulations of Local and State, Federal Governments and other authorities having lawful jurisdiction.
- B. Conform to latest editions and supplements of following codes, standards or recommended practices.
- C. BUILDING CODES:
  - 1. International Codes (Latest adopted version of applicable codes)
- D. SAFETY CODES:
  - 1. National Electrical Safety Code Handbook H30 - National Bureau of Standards.
  - 2. Occupational Safety and Health Standard (OSHA) - Department of Labor.
- E. NATIONAL FIRE CODES:
  - 1. NFPA No. 54 National Fuel Gas Code
  - 2. NFPA No. 70 National Electrical Code
  - 3. NFPA No. 89M Clearances, Heat Producing Appliances
  - 4. NFPA No. 90A Air Conditioning and Ventilating Systems
  - 5. NFPA No. 91 Standard for Exhaust Systems
  - 6. NFPA No. 101 Life Safety Code
  - 7. NFPA No. 204 Standard for Smoke and Heat Venting
- F. UNDERWRITERS LABORATORIES INC:
  - 1. All materials, equipment and component parts of equipment shall bear UL labels whenever such devices are listed by UL.
- G. MISCELLANEOUS CODES:
  - 1. ANSI A117.1 - Handicapped Accessibility
  - 2. Applicable State Boiler Codes
  - 3. Americans with Disabilities Act (ADA)
- H. ENERGY EFFICIENCY REQUIREMENTS:
  - 1. All mechanical systems and components shall be manufactured and installed in compliance with ASHRAE 90.1 – 2007 and latest adopted version of IECC.

#### 1.19. STANDARDS

- A. Drawings and specifications indicate minimum construction standard. Should any work indicated be sub-standard to any ordinances, laws, codes, rules or regulations bearing on work, Contractor shall promptly notify Architect-Engineer in writing before proceeding with work so that necessary changes can be made. However, if the Contractor proceeds with work knowing it to be contrary to any ordinances, laws, rules, and regulations, Contractor shall thereby have assumed full responsibility for and shall bear all costs required to correct non-complying work.

## 1.20. PERMITS/FEES

- A. The Contractor shall secure and pay for necessary permits and certificates of inspection required by governmental ordinances, laws, rules or regulations. Keep a written record of all permits and inspection certificates and submit two copies to Architect-Engineer with request for final inspection.
- B. The Contractor shall include in their base bid any fees or charges by the local utility providers to establish new services to the structure. Coordinate with the utility suppliers to verify exactly which part of the work required for the new utility service, is to be performed by the contractor and which part will be supplied by the utility company.

## PART 2 - PRODUCTS

### 2.1. Not Used

## PART 3 - EXECUTION

### 3.1. SUBMITTALS

- A. Contractor shall furnish submittals of all materials and equipment required by the specifications. Refer to each specification section for the submittals (if any) required for that section.
- B. Submittal format shall be as indicated below. Submittals not meeting these requirements will be returned without action for re-submittal.
  - 1. Submittals shall be furnished in an Adobe PDF format.
  - 2. Submittals shall be per individual submittal section, as listed in the table of contents. All required submittals within that section shall be grouped together in a single submittal.
    - a. Furnishing submittals by division or by individual item may result in delayed reviewing of the submittal(s) due to additional administrative time required to process the large size and/or quantity of files.
  - 3. Submittals shall have a cover page containing the following information: The project name, the applicable specification section and paragraph, the submittal date, and the Contractor's stamp (see below for requirements).
  - 4. Mark each submitted item as applicable with scheduled mark, name, etc. corresponding to the plans.
  - 5. Where generic catalog cuts are submitted for review, conspicuously mark or provide schedule of equipment, capacities, controls, fitting sizes, etc. that are to be provided. Each catalog sheet shall bear the equipment manufacturer's name and address.
  - 6. Where equipment submitted does not appear in base specifications or specified equivalent, mark submittals with applicable alternate numbers, change order number or letters of authorization.
  - 7. All submittals on materials and equipment listed by UL shall indicate UL approval on submittal.
- C. Contractor review:
  - 1. Contractor shall check all submittals to verify that they meet specifications and/or drawings requirements before forwarding submittals to the Architect-Engineer for their review. All submittals submitted to Architect-Engineer shall bear contractor's approval stamp that shall indicate that Contractor has reviewed submittals and that they meet specification and/or drawing requirements. Contractor's submittal review shall specifically check for but not be limited to the following: equipment capacities, physical size in relation to space allowed; electrical characteristics, provisions for supply, return and drainage connections to building systems. All submittals not meeting Contractor's approval shall be returned to their supplier for re-submittal.
  - 2. No submittals will be considered for review by the Architect-Engineer without Contractor's approval stamp, or that have extensive changes made on the original submittal as a result of the Contractor's review.
  - 3. Before submitting shop drawings and material lists, verify that all equipment submitted is mutually compatible and suitable for the intended use. Verify that all equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- D. Review Schedule:
  - 1. The shop drawing / submittal dates shall be at least as early as required to support the project schedule and shall also allow for two weeks Architect-Engineer review time plus a duplication of this time for re-submittal if required.
  - 2. Submittal of all shop drawings as soon as possible after permitting approval but before construction starts is preferred.
  - 3. Approval of shop drawings submitted prior to receipt of a permit for that respective scope of work should be considered conditional pending review/approval of the construction documents by the AHJ. Changes required to the submittal as a result of permitting comments received after architect's/engineer's review shall not be a justification for a change in price.
  - 4. Any time delay caused by correcting and re-submitting submittals/shop drawings will be the Contractor's

responsibility.

- E. The Architect's-Engineer's checking and subsequent review of such drawings, schedules, literature, or illustrations shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Architect's-Engineer's attention to such deviations at the time of submission, and secured their written approval; nor shall it relieve the contractor from responsibility for errors in dimensions, details, size of members, or omissions of components for fittings; or for coordinating items with actual building conditions and adjacent work.
- F. Any corrections or modifications made by the Architect-Engineer shall be deemed acceptable to the Contractor at no change in price unless written notice is received by the Architect-Engineer prior to the performance of any work incorporating such corrections or modifications.
- G. Submittals that require re-submission shall have the items that were revised "flagged" or in some other manner marked to call attention to what has been changed.
- H. Coordination

1. After shop drawings have been reviewed and approved by all parties, transmit a set of submittals to each other trade (eg Plumbing, Mechanical, Electrical, Controls, etc) that will interface with installation. Each other contractor shall review the submittal for coordination and return a stamped submittal indicating they have reviewed the submittal for coordination purposes.

### 3.2. SHOP DRAWINGS

- A. Shop drawings shall meet all of the above requirements for submittals.
- B. Contractor shall submit Adobe PDF sets of all fabrication drawings. Cost of drawing preparation, printing and distribution shall be paid for by the contractor and included in his base bid.
- C. No work shall be fabricated until Architect-Engineer's review has been obtained.
- D. Sheet metal shop drawings for duct fabrication shall be a minimum of 1/4" scale. Sheet metal shop drawings shall not be a reproduction of the contract document and shall show details of the following: Fabrication, assembly, and installation, including plans, elevations above finished floor, sections, components, and attachments to other work. Duct layout indicating pressure classifications and sizes on plans, fittings, reinforcement and spacing, seam and joint construction, penetrations through fire-rated and other partitions, hangers and supports, including methods for building attachment, vibration isolation, seismic restraints, and duct attachment.

### 3.3. OPERATING AND MAINTENANCE INSTRUCTIONS (O & M MANUALS)

- A. Submit with shop drawings of equipment, four copies of installation, operating, maintenance instructions, and parts lists for equipment provided. Equipment manufacturer shall prepare instructions.
- B. Keep in safe place, keys and wrenches furnished with the equipment provided under this contract. Present to the Owner and obtain a receipt for them upon completion of project.
- C. Prepare a complete brochure, covering systems and equipment provided and installed under this contract. Submit brochures to Architect-Engineer for review before delivery to Owner. Brochures shall contain following:
  - 1. Certified equipment drawings/or catalog data with equipment provided clearly marked as outlined above.
  - 2. Record copy of all submittals indicating actual equipment installed indicating options, characteristics. Copies of submittals shall bear the stamps of all parties that reviewed submittals.
  - 3. Complete installation, operating, maintenance instructions and parts lists for each item of equipment.
  - 4. Special emergency operating instructions with a list of service organizations (including addresses and telephone numbers) capable of rendering emergency service to various parts of mechanical system.
- D. Provide brochures bound in three-ring binders with metal hinge. Reinforce binding edge of each sheet of loose-leaf type brochure to prevent tearing from continued usage. Clearly print on label insert of each brochure:
  - 1. Project name and address.
  - 2. Section of work covered by brochure, i.e., "Plumbing", etc.

### 3.4. RECORD DOCUMENTS

- A. A. During construction, keep an accurate record of all deviations between the work as shown on Drawings and that which is actually installed. Keep this record set of prints at the job site for review by the Architect/Engineer.
- B. Upon completion of the installation and acceptance by the owner, transfer all record drawing information to one neat and legible set of prints. Then deliver them to the Architect/Engineer for transmittal to the Owner.
- C. Provide one copy of on high quality heavy weight presentation type paper. Blueprints or other media which fade shall not be used.
- D. Provide one electronic scanned version of record documents in Adobe PDF format on a DVD. Transmit DVD in conjunction with hard copy documents.

### 3.5. CLEANING UP

- A. Contractor shall take care to avoid accumulation of debris, boxes, crates, etc., resulting from the installation of his work. Contractor shall remove from the premises each day all debris, boxes, etc., and keep the premises clean.
- B. Contractor shall clean up all ductwork and equipment at the completion of the project.
- C. All equipment, cabinets and enclosures shall be thoroughly vacuumed clean prior to energizing equipment and at the completion of the project. Equipment shall be opened for observation by the Architect/Engineer as required.

### 3.6. WATERPROOFING

- A. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, perform it prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect/Engineer and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
- B. If Contractor penetrates any walls or surfaces after they have been waterproofed, he shall restore the waterproof integrity of that surface as directed by the Architect/Engineer at his own expense

### 3.7. CUTTING AND PATCHING

- A. Contractor shall do cutting and patching of building materials required for installation of work herein specified. Remove walls, ceilings and floors (or portions thereof) necessary to accomplish scope of work. Do not cut or drill through structural members including wall, floors, roofs, and supporting structure, without the Architect's and Structural Engineer's approval and in a manner approved by them.
- B. Make openings in concrete with concrete hole saw or concrete drill. Use of star drill or air hammer for this work will not be permitted.
- C. Patching shall be by the contractors of the particular trade involved, shall match the existing construction type, quality, finish and texture, and shall meet approval of Architect-Engineer. Damage to building finishes, caused by installation of mechanical work shall be repaired at Contractor's expense to approval of Architect-Engineer.

### 3.8. SETTING, ADJUSTMENT AND EQUIPMENT SUPPORTS

- A. Work shall include mounting, alignment and adjustment of systems and equipment. Set equipment level on adequate foundation and provide proper anchor bolts and isolation as shown, specified or required by manufacturers in installation instructions. Level, shim and grout equipment bases as recommended by manufacturer. Mount motors, align and adjust drive shafts and belts according to manufacturer's instructions.
- B. Equipment failures resulting from improper installation or field alignment shall be repaired or replaced by Contractor at no cost to Owner.
- C. Floor or pad mounted equipment shall not be held in place solely by its own dead weight. Include anchor fastening in all cases.
- D. Provide floor or slab mounted equipment with 3-1/2" high concrete bases unless specified otherwise. Mechanical contractor shall form all pads; General contractor shall provide and place all concrete and reinforcing for said pads. Individual concrete pad shall be no less than 4" wider and 4" longer than equipment, and shall extend no less than 2" from each side of equipment.
- E. Provide each piece of equipment or apparatus suspended from ceiling or mounted above floor level with suitable structural support, platform or carrier in accordance with best-recognized practice. Verify that structural members of buildings are adequate to support equipment and unless otherwise indicated on plans or specified, arrange for their inclusion and attachment to building structure. Provide hangers with vibration isolators.
- F. Submit details of hangers, platforms and supports together with total weights of mounted equipment to Architect-Engineer for review before proceeding with fabrication or installation.

### 3.9. START-UP, CHANGEOVER, TRAINING AND OPERATIONAL CHECK

- A. Contractor shall perform the initial start-up of the systems and equipment and shall provide necessary supervision and labor to make the first seasonal changeover of systems. Personnel qualified to start-up and service this equipment, including manufacturer's technicians, and the Owner's operating personnel shall be present during these operations.
- B. Contractor shall be responsible for training Owner's operating personnel to operate and maintain the systems and equipment installed. Keep a record of training provided to Owner's personnel listing the date, subject covered, instructors name, names of Owner's personnel attending and total hours of instruction given each individual.
- C. All owner-training sessions shall be orderly and well organized and shall be video recorded digitally. At the end of the owner training, the "training" session recording shall be transmitted to the owner via DVD and shall become property of the owner.

3.10. FINAL CONSTRUCTION REVIEW

- A. At final construction review, each respective Contractor and major subcontractors shall be present or shall be represented by a person of authority. Each Contractor shall demonstrate, as directed by the Architect-Engineer, that the work complies with the purpose and intent of the contract documents. Respective Contractor shall provide labor, services, instruments or tools necessary for such demonstrations and tests.

**END OF SECTION 230010**



## SECTION 230011 – BASIC MECHANICAL MATERIALS AND METHODS

### PART 1 - GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 230010.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. SUBMITTALS

- A. Provide documentation of all completed tests described herein and their results.

### PART 2 – PRODUCTS (NOT APPLICABLE)

### PART 3 - EXECUTION

#### 3.1. TESTING PROCEDURES FOR PIPING SYSTEMS

- A. Test all lines and systems before they are insulated, painted or concealed by construction or backfilling. Provide fuel, water, electricity, materials, labor and equipment required for tests.
- B. Where entire system cannot be tested before concealment, test system in sections. Verify that system components are rated for maximum test pressures to be applied. Where specified test pressures exceed component ratings, remove or isolate components from system during tests. Upon completion, each system shall be tested as an entire system.
- C. Repair or replace defects, leaks and material failures revealed by tests and then retest until satisfactory. Make repairs with new materials.
- D. All systems shall hold scheduled test pressures for specified time without loss of initial test pressure.
- E. Upon completion of testing submit five copies of a typewritten report to A/E. Report shall list systems tested, test methods, test pressures, holding time and all failures with corrective action taken.
- F. For test pressure schedules see piping material schedules.

#### 3.2. TEST METHODS AND PRESSURES

- A. Test methods and pressures shall be as follows:
  - 1. Hydrostatic Test (Closed Systems):
    - a. Hydrostatic test shall be performed using clean unused domestic water. Test pressures shall be as scheduled for system or 150% of operating pressure where not specified.
  - 2. Hydrostatic Test (Open System):
    - a. Test entire system with 10-foot head of water. Where system is tested in sections each joint in building except uppermost 10 feet of system shall be submitted to at least 10-foot head of water. Water shall be held in system for 15 minutes before inspection starts. System shall hold test pressure without leaks.
  - 3. Pneumatic Test:
    - a. Test entire system with compressed air. Systems operating above 25 PSI shall be tested at 75 PSI or 15% of operating pressure or whichever is greater.
    - b. Allow at least 1 hour after test pressure has been applied before making initial test.
    - c. Curing test, completely isolate entire system from compressor or other sources of air pressure.
  - 4. Pressure Relief and Safety Valve:
    - a. Before installation, test pressure temperature, and safety relief valves to confirm relief settings comply with specifications.
    - b. Tag items that pass test with date of test, observed relief pressure setting and inspector's signature.
    - c. Items installed in systems without test tag attached will be rejected.

#### 3.3. TESTING OF REFRIGERANT LINES

- A. After the system is installed and before any piping is insulated, the entire refrigeration circuit must be thoroughly leak tested. Test all pipe joints for leaks. Make certain that all joints are inspected thoroughly. Mark carefully any spots where leaks occur.
- B. Leaks are repaired by disassembling the connection, cleaning the fitting and remaking. No attempt should be made to repair a leak by simply adding brazing material.

#### 3.4. MISCELLANEOUS CONTROL WIRING

- A. All control wiring regardless of voltage shall be routed in a concealed manner.
- B. All exterior control wiring shall be installed in conduit.
- C. Wiring to thermostats and other wall mounted devices and sensors shall be routed in ¾" conduit to backboxes in walls and to an accessible ceiling or location.
- D. All conduit and wiring shall be installed in accordance with Division 26.
- E. Cabling and circuiting shall be plenum rated where required.
- F. Refer to additional specifications where systems and controls are specified as DDC or similar.

#### 3.5. CLEANING OF SYSTEMS AND EQUIPMENT

- A. After pressure testing of systems and equipment and before operational test thoroughly clean interiors of piping and equipment. Clean equipment as recommended by equipment manufacturers. Where specific instructions are not provided clean equipment systems as follows:

##### 1. Air Handling Systems:

- a. Before starting any air system clean all debris, foreign matter and construction dirt from air system and fan. Provide equipment requiring filters, such as air handling units, fan coil units, blower, etc., with throw-away filters. After cleaning air system install temporary filters and run continuously for a minimum of eight hours at full volume before installing permanent filters. Provide temporary throw-away filters in all permanent heating and air conditioning equipment systems being utilized during construction. Prior to testing and balancing systems remove temporary filter media and install clean unused filters of the type specified. Clean filters shall be installed in equipment by mechanical contractor before final acceptance inspection by Architect and Engineer.

#### 3.6. MAINTENANCE OF SYSTEMS

- A. Contractor shall be responsible for operation, maintenance and lubrication of equipment installed under this contract.
- B. Keep a complete record of equipment maintenance and lubrication and submit two copies with request for final construction review.
- C. Records shall indicate types of lubricants used and date or time when next maintenance or lubrication will need to be performed by Owner. Where special lubricants are required, Contractor shall provide Owner with a one year supply as determine by Equipment Manufacturer's recommendations.

#### 3.7. PAINTING OF MATERIALS AND EQUIPMENT

- A. Touch-up painting and refinishing of factory applied finishes shall be by Mechanical Contractor. Contractor shall be responsible for obtaining proper type of painting materials and color from equipment manufacturer.
- B. Unless specified otherwise factory built equipment shall be factory painted. Paint shall be applied over surfaces only after they have been properly cleaned and coated with a corrosion resistant primer.
- C. After installation, damage to painted surfaces shall be properly prepared and primed with primers equal to factory materials. Finish coating shall be same color and type as factory finish.
- D. Where extensive refinishing is required equipment shall be completely repainted.

#### 3.8. FIRE BARRIERS

##### A. General

- 1. For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

##### B. Submittals

- 1. Product Data: For Each Type Of Product Indicated.

- 2. Shop Drawings: For Each Through-Penetration Firestop System, Show Each Type Of Construction Condition Penetrated, Relationships To Adjoining Construction, And Type Of Penetrating Item. Include Firestop Design Designation Of Qualified Testing And Inspecting Agency That Evidences Compliance With Requirements For Each Condition Indicated.

- a. Submit Documentation, Including Illustrations, From A Qualified Testing And Inspecting Agency That Is Applicable To Each Through-Penetration Firestop System Configuration For Construction And Penetrating Items.
- b. Where Project Conditions Require Modification To A Qualified Testing And Inspecting Agency's Illustration For A Particular Through-Penetration Firestop Condition, Submit Illustration, With

Modifications Marked, Approved By Through-Penetration Firestop System Manufacturer's Fire-Protection Engineer As An Engineering Judgment Or Equivalent Fire-Resistance-Rated Assembly.

3. Through-Penetration Firestop System Schedule: Indicate Locations Of Each Through-Penetration Firestop System, Along With The Following Information:

- a. Types Of Penetrating Items.
  - b. Types Of Constructions Penetrated, Including Fire-Resistance Ratings And, Where Applicable, Thicknesses Of Construction Penetrated.
  - c. Through-Penetration Firestop Systems For Each Location Identified By Firestop Design Designation Of Qualified Testing And Inspecting Agency.
- C. Product Certificates: For through-penetration firestop system products, signed by product manufacturer.
  - D. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
  - E. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
  - F. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by building inspector, if required by authorities having jurisdiction.
  - G. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.
  - H. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
  - I. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated.
  - J. Provide sleeves through all fire-rated walls and fill voids surrounding sleeves and interior to sleeves around piping with Nelson "Flameseal" fire stop putty with U.L. listed 3 hour rating installed as per manufacturers recommendations.
  - K. Equivalent by Hilti, Inc., Johns Manville, Nelson Firestop Products, NUCO Inc., RectorSeal Corporation, Specified Technologies Inc., 3M, Tremco, USG, Dow, Chemelex.

### 3.9. EQUIPMENT ANCHORS

- A. Provide floor or foundation mounted equipment such as pumps, boilers, air handling units, etc. with Decatur Engineering Company concrete anchors.
- B. Where equipment anchors cannot be installed during forming of floors or foundations anchor equipment with McCulloch Kwik-Bolt concrete anchors.
- C. Anchors shall be proper type and size recommended by manufacturer for equipment to be anchored.

### 3.10. WELDING

- A. Contractor shall be responsible for quality of welding and suitability of welding procedures. All welding shall be in accordance with American Welding Society Standard B3.0 and ANSI Standard B31.1.
- B. Welded pipe joints shall be made by certified welding procedures and welders. Welding electrodes shall be type and material recommended by electrode manufacturer for materials to be welded. All pipe and fittings ends shall be beveled a minimum of 30 degrees prior to welding.
- C. Only welders who have successfully passed welder qualifications tests in previous 12 months for type of welding required shall do welding. Each welder shall identify his work with a code marking before starting any welded pipe fabrication. Contractor shall submit three copies of a list of welders who will work on project listing welders' code, date and types of latest qualification test passed by each welder.
- D. Welded joints shall be fusion welded in accordance with Level AR3 of American Welding Society Standard AWS D10.9 "Standard for Qualification of Welding Procedures and Welders for Pipe and Tubing". Welders qualified under National Certified Pipe Welding Bureau will be acceptable.
- E. Bevel all piping and fittings in accordance with recognized standards by flame cutting or mechanical means. Align and position parts so that branches and fittings are set true. Make changes in direction of piping systems with factory made welding fittings. Make branch connections with welding tees or forged weldolets.

**END OF SECTION 230011**



## SECTION 230013 – PROJECT COORDINATION

### PART 1 GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2. SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. Coordination Drawings.
  - 2. Administrative and supervisory personnel.
  - 3. Project meetings.
  - 4. Requests for Interpretation (RFIs).
- B. Each related sub-contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific contractor.

#### 1.3. COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
- B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.
  - 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
  - 1. Delivery and processing of submittals.
  - 2. Progress meetings.
  - 3. Preinstallation conferences.
  - 4. Project closeout activities.
  - 5. Startup and adjustment of systems.

#### 1.4. SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
  - 1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
    - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    - b. Indicate required installation sequences.
    - c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
  - 2. Sheet Size: At least 8-1/2 by 11 inches but no larger than 30 by 40 inches. Format shall be PDF or other electronic format to facilitate multiple user commenting and sharing easily.

3. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.
  - B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including project managers, superintendent and other personnel in attendance at Project site to the General Contractor and other major subcontractors. Identify individuals and their duties and responsibilities; list email addresses and telephone numbers. Update the list as required during the project if personnel change.

#### 1.5. COORDINATION

- A. Certain materials will be provided by other trades. Examine the Contract Documents and reviewed record Submittals to ascertain these general requirements. Contract Documents reflect a basis of design and may not reflect actual equipment or items being utilized.
  - B. Carefully check space requirements with other trades and the physical confines of the area to insure that all material can be installed in the spaces allotted thereto including finished suspended ceilings and the spaces within the existing building. Make modifications thereto as required and approved.
  - C. Transmit to other trades all information required for work to be provided under their respective Sections in ample time for installation.
  - D. Wherever work interconnects with work of other trades, coordinate with other trades to insure that all trades have the information necessary so that they may properly install all the necessary connections and equipment. Identify all items of work that require access so that the ceiling trade will know where to install access doors and panels.
  - E. Obtain equipment submittal information for all pieces of equipment to be connected to from other trades that clearly indicates all connection requirements, locations, sizes, and similar requirements. Obtain this information in ample time to coordinate other trade submittals and equipment coordination. Where requirements differ from that on plans or differs from provisions made in the work, immediately notify the Architect/Engineer. Do not proceed with work that is incompatible with equipment provided.
  - F. Coordinate, project and schedule work with other trades in accordance with the construction sequence.
  - G. Coordinate with the local Utility Companies to their requirements for service connections and provide all necessary materials, labor and testing.
  - H. Coordinate with contractors for work under other Divisions of this specification for all work necessary to accomplish this contractor's work.
  - I. Conduct a coordination meeting after reviewing all other trade coordination drawings with other relevant trades. This meeting shall be held to prevent conflicts during construction. Each major relevant subcontractor shall attend this meeting. Report any potential conflicts or clearance problems to Architect/Engineer after meeting.
  - J. Adjust location of piping, ductwork, conduit, wiring, etc. to prevent interferences, both anticipated and encountered. Determine the exact route and location of each item prior to fabrication.
1. Right-of-Way:
    - a. Lines that pitch have the right-of-way over those that do not pitch. For example: steam, condensate, and plumbing drains normally have right-of way. Lines whose elevations cannot be changed to have right-of-way over lines whose elevations can be changed.
    - b. Make offsets, transitions and changes in direction in raceways as required to maintain proper headroom in pitch of sloping lines whether or not indicated on the Drawings.

#### 1.6. DRAWINGS AND FILES.

- A. The Drawings show only the general run of MEP systems, equipment, fixtures, piping and ductwork and other components as well as approximate location of items such as outlets, switches, diffusers, lights, and equipment connections, etc. Coordinate all exact locations of items with other trades, architectural elevations, equipment requirements, owner requirements, ceilings, access, serviceability, etc. All such modifications and coordination shall be made without additional cost to the Owner. Any significant changes in location of items necessary in order to meet field conditions shall be brought to the immediate attention of the Architect/Engineer and receive his approval before such alterations are made
- B. Wherever the work is of sufficient complexity, additional Detail Drawings to scale similar to that of the bidding Drawings, prepared on tracing medium of the same size as Contract Drawings. With these layouts, coordinate the work with the work of other trades. Such detailed work to be clearly identified on the Drawings as to the area to which it applies. Submit for review Drawings clearly showing the work and its relation to the work of other trades before commencing shop fabrication or erection in the field. Attend meetings with other trades to review all documents.
- C. When directed by the General Contractor for areas of necessary coordination provide 3D building modelling coordination files and documents with other trades. Transmit information electronically and attend meetings as directed by the G/C as well as take part in coordination activities and documentation. Contractor shall be required to generate their own electronic files for this process.

## 1.7. PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

- a. The Contract Documents.
- b. Options.
- c. Related RFIs.
- d. Related Change Orders.
- e. Purchases.
- f. Deliveries.
- g. Submittals.
- h. Possible conflicts.
- i. Compatibility problems.
- j. Time schedules.
- k. Manufacturer's written recommendations.
- l. Warranty requirements.
- m. Compatibility of materials.
- n. Space and access limitations.
- o. Regulations of authorities having jurisdiction.
- p. Testing and inspecting requirements.
- q. Installation procedures.
- r. Coordination with other work.
- s. Required performance results.
- t. Protection of adjacent work.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

C. Coordination Meetings: Conduct Project coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

- a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contractor is on time, ahead or behind schedule, in relation to Construction Schedule. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time. Discuss impact of various contractor schedules upon other contractors and how to remedy impacts.
- b. Review present and future needs of each contractor present, including the following:
  - i. Interface requirements.
  - ii. Sequence of operations.
  - iii. Status of submittals.

- iv. Deliveries.
- v. Off-site fabrication.
- vi. Access.
- vii. Quality and work standards.
- viii. Change Orders.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.8. REQUESTS FOR INTERPRETATION (RFIs)

A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI.

1. Submit Contractor's suggested solution(s) to RFI. If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.

2. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

**END OF SECTION 220013**



## SECTION 230505 – MECHANICAL DEMOLITION

### PART 1 - GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 220500.
- B. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. SUMMARY

- A. This Section requires the selective removal and subsequent offsite disposal of the following:
  1. Mechanical and electrical equipment, devices, piping, conduits, ductwork, insulation, lighting, etc in existing building indicated on drawings and as required to accommodate new construction.
  2. Removal of MEP items in interior partitions as indicated on drawings.
  3. Removal and protection of existing fixtures, materials, and equipment items indicated to be removed, salvaged, relocated, reinstalled, etc.

#### 1.3. SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Schedule indicating proposed sequence of operations for selective demolition work to Architect for review prior to start of work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control protection.
  1. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.
  2. Coordinate with Owner's continuing occupation of portions of existing building and with Owner's partial occupancy of completed remodeled areas.
    - C. Photographs of existing conditions of structure surfaces, equipment, and adjacent improvements that might be misconstrued as damage related to removal operations. File with Architect prior to start of work.

#### 1.4. JOB CONDITIONS

- A. Occupancy:
  1. Owner will occupy portions of the building immediately adjacent to areas of selective demolition. Conduct selective demolition work in such a manner that will minimize need for disruption of Owner's normal operations. Provide minimum of 72 hours advance notice to Owner of demolition activities that will affect Owner's normal operations.
- B. Condition of Structures:
  1. Owner assumes no responsibility for actual condition of items or structures to be demolished. Conditions existing at time of Contractor's inspection for bidding purposes will be maintained by Owner insofar as practicable. However, minor variations within structure may occur by Owner's removal and salvage operations prior to start of selective demolition work.
  2. Partial Demolition and Removal: Items indicated to be removed but of salvageable value to Contractor may be removed from structure as work progresses. Transport salvaged items from site as they are removed. Storage or sale of removed items on site will not be permitted.
  3. Protections: Provide temporary barricades and other forms of protection to protect Owner's personnel and general public from injury due to selective demolition work.
  4. Provide protective measures as necessary and required to provide free and safe passage of Owner's personnel and general public to any occupied portions of building.
  5. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain.
  6. Protect from damage existing finish work that is to remain in place and becomes exposed during demolition operations.
  7. Construct temporary insulated dustproof partitions where required to separate areas where noisy or extensive dirt or dust operations are performed. Equip partitions with dustproof doors and security locks.
  8. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
  9. Remove protections at completion of work.
- C. Damages:
  1. Promptly repair damages caused to adjacent facilities by demolition work.

D. Traffic:

1. Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close, block, or otherwise obstruct streets, walks, or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

E. Flame Cutting:

1. Do not use cutting torches for removal until work area is cleared of flammable materials. At concealed spaces, such as interior of ducts and pipe spaces, verify condition of hidden space before starting flame-cutting operations. Maintain portable fire suppression devices during flame-cutting operations.

F. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.

1. Do not interrupt utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.

G. Maintain fire protection services during selective demolition operations.

H. Environmental Controls:

1. Use water sprinkling, temporary enclosures, and other methods to limit dust and dirt migration. Comply with governing and/or approved regulations pertaining to environmental protection. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1. PREPARATION

A. General:

1. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of areas to be demolished and adjacent facilities to remain.
2. Cease operations and notify Architect immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.

B. Erect and maintain dust-proof partitions and closures as required to prevent spread of dust or fumes to any occupied portions of the building.

C. Where selective demolition occurs immediately adjacent to any occupied portions of the building, construct dust-proof partitions of minimum 4-inch studs, 5/8-inch drywall (joints taped) on occupied side, 1/2-inch fire-retardant plywood on demolition side. Fill partition cavity with sound-deadening insulation as required by Architect.

1. Provide weatherproof closures for exterior openings resulting from demolition work.

D. Locate, identify, stub off, and disconnect utility services that are not indicated to remain. Provide bypass connections as necessary to maintain continuity of service to any occupied areas of building. Provide minimum of 72 hours advance notice to Architect if shutdown of service is necessary during changeover.

3.2. DEMOLITION

A. General:

1. Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.

B. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.

C. Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors, or framing.

D. Provide services for effective air and water pollution controls as required.

E. Completely fill below-grade areas and voids resulting from demolition work. Provide fill consisting of approved earth, gravel, or sand, free of trash and debris, stones over 6 inches in diameter, roots, or other organic matter.

F. If unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to architect in written accurate detail. Pending receipt of directive from Architect, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.

### 3.3. SALVAGED MATERIALS

- A. Salvaged Items: Where indicated on Drawings as "Salvage - Deliver to Owner," carefully remove indicated items, clean, store, and turn over to Owner and obtain a receipt.

### 3.4. DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove debris, rubbish, and other materials resulting from demolition operations from building site. Transport and legally dispose off site.
- B. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
- C. Burning of removed materials is not permitted on Project site.

### 3.5. CLEANUP AND REPAIR

- A. General:

1. Upon completion of demolition work, remove tools, equipment, and demolished materials from site. Remove protections and leave interior areas broom clean. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start operations. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

**END OF SECTION 230505**

## SECTION 230548 – MECHANICAL SOUND AND VIBRATION CONTROL

### PART 1 - GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 230010.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. SUBMITTALS

- A. Product Data: For each type of vibration isolation product to be used.

### PART 2 - PRODUCTS

#### 2.1. GENERAL

- A. Equivalents by Amber-Booth Company, Mason Industries, Peabody Noise Control (Kinetics).

#### 2.2. VIBRATION ISOLATION

- A. Furnish and install vibration isolation devices for rotating or reciprocating mechanical equipment and piping systems attached thereto.
- B. Work shall include all material and labor required for installation of the resilient mounting and suspension systems, adjusting each mounting system, and measurement of isolator system performance when so requested by the Architect-Engineer. Specific mounting arrangements for each item of mechanical equipment shall be as described herein and as indicated by schedules and details on the drawings.
- C. All vibration isolation equipment, including steel framing and reinforcing for concrete inertia bases and including steel rail bases, shall be furnished by one of the following manufacturers: A single manufacturer for all vibration isolation equipment will be required except as specifically approved in writing by the Architect-Engineer or by his specific approval of shop drawings.
- D. The Contractor and the vibration isolation manufacturer or his regularly designated and factory authorized representative shall perform the following tasks in addition to the supply and installation of isolation equipment:
- E. Obtain from the Architect-Engineer the approved manufacturer's name, model number, and other necessary identifying data for each item of mechanical and electrical equipment to be resiliently mounted. Coordinate all resilient mounting systems with the exact equipment to be furnished in regard to physical size, isolator locations, weight, rotating speed, etc. Direct contact and cooperation between the vibration isolation device fabricator and the equipment manufacturer will be required.
- F. Obtain all necessary data in regard to piping systems which are to be resiliently supported so that proper isolators can be selected. Select piping system isolators for proper coordination with the physical arrangement of pipe lines and with the physical characteristics of the building.
- G. Submit shop drawings as required by other portions of this specification. These drawings shall include specification information as follows:
  - 1. Manufacturer's model number for each isolator, the machine or pipeline to which it is to be applied, and the number of isolators to be furnished for each machine or pipeline.
  - 2. For steel spring mounts or hangers - free height, deflected height, solid height, isolator loading, and diameter of spring coil.
  - 3. For elastomer or glass fiber isolators - free height, deflected height, and isolator loading.
  - 4. Dimensional and weight data for concrete inertia bases, steel and rail bases, and details of isolator attachment.
- H. Provide on-the-job supervision as required during installation of resiliently mounted equipment and piping to assure that all vibration isolators are installed in strict accordance with normally accepted practices for critical environments.
- I. Replace at no extra cost to the Owner any isolators which do not produce the required deflection, are improperly loaded above or below their operating height, or which in any way do not produce the required isolation.
- J. The vibration isolation systems described herein and identified by type letter designations shall be applied to specific classifications of mechanical and electrical equipment as indicated in this specification.
- K. TYPE A ISOLATION
  - a. The equipment shall be rigidly mounted on a large reinforced concrete inertia block which has length and width dimensions approximately 20% greater than the supported equipment. The inertia block and equipment shall be supported by steel spring vibration isolators. Brackets for the spring isolators shall be located off the sides of the inertia block with the tops of the springs near the vertical center of gravity of the equipment and inertia block; or if the center of gravity is higher than the top of the inertia block, the tops of the springs shall be at the top of the inertia

base. The spring isolators shall rest on curbs or pedestals if necessary. There shall be a 2 inch minimum space between the bottom of the inertia base and the top of the housekeeping pad or floor slab when a housekeeping pad is not indicated on the drawings.

- b. Concrete inertia bases shall be formed by a welded steel channel frame which incorporates prelocated equipment anchor bolts, and minimum 1/2 inch diameter reinforcing bars on minimum 8 inch centers each way welded in place. Concrete shall be standard 150-160 lb./cu. ft. structural concrete. The base thickness shall be determined by the weight requirements but it shall be a minimum of 8% of the longest span between isolators or 6 inches, whichever is greater. For centrifugal and axial fans and centrifugal pumps the inertia base shall have a minimum weight equal to that of the isolated equipment. For reciprocating equipment the inertia base shall have a minimum weight equal to twice the weight of the equipment.
- c. Springs shall be of the free standing unhooused type. Horizontal spring stiffness shall not be less than 0.8 of vertical stiffness. Springs shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection of each spring shall not be less than that specified for each classification of mechanical equipment. The spring deflection from the point of rated deflection to the point at which the spring is solid shall not be less than 1/2 of the rated static deflection. The yield point of the steel used in the springs shall be sufficiently great so that the springs may be compressed to shorted turns without danger of spring failure. At least two layers of ribbed waffle pattern neoprene pads or equivalent glass fiber pads shall be installed under the base plate of each spring isolator. Springs shall have leveling bolts and proper means for bolting to the machines. To prevent corrosion, springs for outdoor installation shall be galvanized or otherwise coated as approved by the Architect-Engineer.

#### L. TYPE B ISOLATION

- a. The equipment shall be rigidly mounted on wide flange or channel structural steel members which shall run perpendicular to any support channels or similar members which are an integral portion of the equipment, or which shall be fabricated to form a complete frame for machine mounting. Height saving spring mounting brackets shall be welded to the ends of the structural steel saddle members or to the sides of structural steel saddle members or to the sides of structural steel frames to attach free standing steel spring isolators. Unless otherwise approved, the depth of the structural steel saddle members or the perimeter members of mounting frames shall be at least one-tenth of the longest frame dimension.
- b. Steel spring isolators shall be as specified for Type A isolation.
- c. Minimum clearance between the steel base and the housekeeping pad or floor shall be 2 inches.

#### M. TYPE C ISOLATION

- a. The equipment shall be rigidly mounted in a steel frame which is sufficiently stiff so that it may be supported on resilient isolators without distortion of the frame or mis-alignment of the equipment. If the equipment has an integral frame which is suitably rigid, then the resilient isolators may be secured directly to the integral equipment frame or base.
- b. Isolators shall be selected on the basis of the required static deflection as scheduled or specified, and as follows:
- c. Required deflection 0.25 to 0.4 inches - double deflection neoprene-in-shear isolators.
- d. Required deflection 0.5 inches and greater - steel spring isolators as specified for the Type A mounting.
- e. Isolators shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection shall not be less than that specified for each classification of equipment.
- f. Minimum clearance between the equipment base and the housekeeping pad or floor shall be 2 inches.

#### N. TYPE D ISOLATION

1. The equipment shall be suspended with steel spring vibration isolators which are complete with neoprene-in-shear isolators for high frequency noise control. The neoprene-in-shear isolators shall provide static deflection of 0.20 inches minimum. In addition, elastomer washers shall be furnished as necessary to prevent metal-to-metal contact.
2. Hanger rod misalignment of up to 15 degrees relative to vertical shall not cause "short-circuiting" of the isolation components due to metal-to-metal contact.
3. Spring hangers shall utilize free standing springs which are unhooused except for the required partial and open housing assembly. Spring hangers shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection of each hanger shall not be less than that specified

for each classification of mechanical equipment. The spring deflection from the point of rated deflection to the point at which the spring is solid shall not be less than one-half of the rated static deflection. The yield point of the steel used in the springs shall be sufficiently great so that the springs may be compressed to shorted turns without danger of spring failure.

4. Resilient hangers shall be installed as near as possible to the supporting overhead structure. The machine suspension points shall be in a rigid and heavy portion of the building structure. Suspension of machines from lightweight floor slabs shall be avoided, particularly at the center of structural spans.

5. Suspension rods shall be attached to rigid members of the machine structure. When such attachment points do not exist, a heavy steel framework shall be furnished to support the machine with suspension rods attached to this framework.

O. TYPE E ISOLATION

- a. The equipment shall be suspended with double deflection neoprene-in-shear hangers which are complete with elastomer washers as required to prevent metal-to-metal contact.
- b. Hangers shall be installed as near as possible to the supporting overhead structure. Suspension points shall be on a rigid portion of both the overhead structure and equipment framework.

2. TYPE F ISOLATION (Curb Mounted Roof-Top Air Conditioning Machines)

- a. The roof-top air conditioning machine shall be mounted on a free standing steel spring isolated rectangular rail (curb) system which in turn is mounted on a roof curb as normally used to mount the machine when vibration isolation is not used. The isolation system shall be suitable for outdoor unprotected locations and it shall include a soft and flexible elastomer air and water seal which shall not short circuit the spring isolators. The spring isolators shall provide uniform deflection of not less than 0.9 inch for the entire machine. The isolation system shall not allow lateral movement greater than 5/8 inch for wind loads up to 100 miles per hour. Suitable systems of this type are Peabody Noise Control Type ASR, Mason Industries Type CMAB, and Amber Booth Type RTIR.

PART 3 - EXECUTION

3.1. GENERAL

- A. Cooperate with all other Contractors engaged in this project so that the installation of vibration isolation devices will proceed in a manner that is in the best interests of the Owner.
- B. Notify the Architect-Engineer of any project conditions which affect vibration isolation system installation or performance and which are found to be different from conditions indicated by the drawings or described by the specifications. Should vibration isolation system installation proceed without such notifications any remedial work required to achieve proper isolator performance shall be accomplished by the Contractor at no additional cost to the Owner.
- C. Be alert for possible "short-circuiting" of vibration isolation systems by piping supports, electrical connections, temperature control connections, drain lines, building construction, etc., and notify the involved contractor as to these problems or potential problems. Where such situations cannot be easily resolved, notify the Architect-Engineer so that preventive or remedial action can take place on a timely basis. Any remedial measures required shall be undertaken by the Contractor responsible at no additional cost to the Owner.

3.2. RESILIENT MOUNTINGS FOR SPECIFIC CLASSIFICATIONS OF EQUIPMENT

Equipment	Power(HP) or as Noted	Rotating Speed RPM	Mounting Type	Inertia Base*	Static Deflection**
Pumps all except In-The-Line Type	--	1750	A	2	1.5"
Floor mounted AHU's	1 - 50	500 and Up	B		.75"
Suspended AHU's, fan coils, and other Suspended Equipment	0 - 7-1/2	500 and Up	D		.75"
Rooftop units	7-1/2 - 50	500 and Up	F		.75"

\* Minimum inertia base weight expressed as multiple of weight of supported equipment.

\*\* Minimum static deflection of isolators specified for mounting type indicated.

### 3.3. ISOLATION OF PIPING SYSTEMS

- A. All piping which connects to resiliently mounted equipment shall be suspended with resilient hangers or supported by floor mounted isolators for a distance of 100 pipe diameters from the connected machine or within the mechanical equipment room whichever is the greater distance. The first three supports from the connected machine shall have the same static deflection as indicated for the machine; the next two supports shall have static deflection at least equal to one-half of the static deflection indicated for the machine mounting, and remaining pipe supports shall provide static deflection of 0.35 inches minimum. These remaining isolators may be elastomer.
- B. Steel spring hangers shall be as specified for Type D isolation except that a scale shall be attached to the hanger housing to indicate deflection. Elastomer hangers shall be as specified for Type E isolation. Floor mounts shall be free standing steel spring isolators as specified for Type A isolation where static deflection in excess of 0.35 inches is required. Floor mounts, where static deflection of 0.35 inches or less is required, shall be double deflection neoprene-in-shear as specified for Type C isolation.
- C. Vertical pipe risers shall be resiliently mounted, preferably with each riser anchored near the center of the run. The risers shall be supported at the anchor points with steel spring or double deflection neoprene-in-shear isolators which provide static deflection of at least 0.35 inches. Isolators for the remainder of each run shall be steel spring type specifically designed to control load shifting due to pipe expansion and contraction. At least 0.35 inches deflection shall be maintained under all conditions.
- D. Flexible neoprene connectors shall be used to connect all piping to all isolated equipment except equipment for which flexible connectors are not permitted by code. For this application provide swing connectors changing direction a minimum of 3 times before joining isolated equipment. Swing connections should be made within approximately 6 feet of the isolated equipment. Connectors shall be manufactured of multiple plies of nylon tire cord fabric and neoprene both molded and cured in hydraulic presses. No steel wire or rings shall be used as pressure reinforcement. Connectors up to and including 2" diameter may have threaded ends. Connectors 2-1/2 inches and larger shall be manufactured with floating steel flanges. All connections shall be rated a minimum of 150 psi at 220 degrees F. All flanged equipment shall be directly connected to neoprene elbows in the size range 2-1/2 inches through 6 inches or any larger available size if the piping makes a 90 degree turn at the equipment. All straight through connections shall be made with either flanged or screwed connectors properly pre-extended as recommended by the manufacturer to prevent additional elongation under pressure. Sizes 12 inches and larger operating at pressures above 100 psi shall employ control cables with end fittings isolated from the anchoring plates by means of 1/2 inch thick bridge bearing neoprene washer bushing designed for a maximum of 1000 psi. Elbows shall be Mason-Flex type MFNEC, straight connectors Mason-Flex type MFTFU or MFTNC, and control cables assemblies type ACC, all as manufactured by Mason Industries, Inc.
- E. Drain connections from isolated equipment to floor drains shall be at least 1" free from drain or use rubber hose.

### 3.4. ISOLATION OF FRACTIONAL HORSEPOWER EQUIPMENT

- A. All fractional horsepower fans, pumps, etc., which are mounted on or suspended from floors that are on-grade shall be isolated with neoprene-in-shear isolators furnished by the vibration isolation supplier except where such isolators are furnished as an integral part of the machine.

**END OF SECTION 230548**

## SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1. SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

#### 1.2. SUBMITTAL

- A. Product Data: For each type of product indicated.

### PART 2 - PRODUCTS

#### 2.1. EQUIPMENT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware. Black letters on white background.
- B. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- C. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- D. Fasteners: Stainless-steel rivets or self-tapping screws.
- E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- F. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- G. Install or permanently fasten labels on each major item of mechanical equipment.
- H. Locate equipment labels where accessible and visible.

#### 2.2. VALVE IDENTIFICATION

- A. Mark all valves with Seton No. 300-BL brass identification tags with system legend, valve number and size stamped on tag. Lettering shall be black 1/2" high. Tags shall be minimum 2" in diameter and attached to valve with Seton No. 16 brass jack chain.
- B. Prepare four copies of typewritten list of valve tags. List shall be typed in upper case and contain tag number, valve size, type, function and location. Frame one list under glass and mount near operating instruction in main equipment rooms.

#### 2.3. PIPING IDENTIFICATION

- A. Colors and wording shall be of standard pipe markers as available from Seaton or equal. Submit for approval list of colors and wording prior to purchase of pipe markers.
- B. Pipe marker nomenclature/colors shall meet applicable ANSI Standard and OSHA requirements. Pipe markers with letters and flow direction arrows
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

**END OF SECTION 230553**



## SECTION 230593 – SYSTEM TESTING & BALANCING

### PART 1 - GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 230010.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. TESTING AND BALANCING CONTRACTORS

- A. Testing and balancing (TAB) of the building air and hydronic systems will be to be completed near the end of construction. The Mechanical Contractor has responsibility to cooperate with, make adjustments for, and provide any equipment necessary for the TAB contractor to complete the job.

### PART 2 - PRODUCTS

- A. Not Used

### PART 3 - EXECUTION

#### 3.1. SCOPE OF WORK

- A. The Contractor shall procure the services of an independent air balance and testing contractor, approved by the A/E, which specializes in the balancing and testing of heating, ventilating and air conditioning systems, to balance, adjust, and test air moving equipment and air distribution and exhaust systems and all water flow circuits. All work by this contractor shall be done under engineer employed by them. All instruments used by this contractor shall be accurately calibrated and maintained in good working order. If requested the tests shall be conducted in the presence of the A/E responsible for the project and/or his representative. The testing and balancing contractor shall be certified by NEBB or AABC and all work shall be performed in accordance with these organizations' published procedure manuals.
- B. The balancing contractor shall prepare a certified report of all tests performed. The report shall be written on standard forms prepared by NEBB or AABC or facsimiles thereof. The balancing contractor shall submit 3 copies of this report to the Mechanical Contractor who shall submit them to the A/E for review and distribution.
- C. Air balance and testing shall not begin until systems have been completed and are in full working order. All heating, ventilation, and air conditioning systems and equipment shall be in full operation during each working day of testing and balancing.

#### 3.2. SYSTEM PREPARATION FOR TESTING AND BALANCING

- A. Prior to requesting testing and balancing contractor to perform their work the installing contractor shall make all necessary inspections and adjustments to insure that systems are completely installed and operating in accordance with the manufacturer's recommendations and the contract documents.
- B. The following checks shall be performed on each system installed under this contract. A report sheet shall be prepared for each system indicating checks made, corrective action taken where required, date, and name of person making inspection. Submit one copy to testing and balancing contractor and two to A/E. Testing and balancing contractor will not begin until checklist has been received and reviewed.

#### 3.3. TEMPERATURE CONTROLS CONTRACTOR COORDINATION

- A. The temperature control contractor shall have a technical representative present with the balancing contractor on the first day of balancing for a minimum of four hours of active balancing and temperature controls coordination.
- B. For the remainder of the balancing the temperature contractor may either have a technical representative present, or may furnish the balancer with the latest DDC software and all required interface devices. This includes instructions and coordination in the use of all interface devices, including laptop computers. There shall be no charge to the balancing contractor for the use of these interface devices and they shall be returned to the temperature controls contractor at the end of the balancing process.

#### 3.4. AIR HANDLING SYSTEMS:

- A. Clear system of all foreign objects and clean system.
- B. Verify fan rotation.
- C. Check bearing condition and lubrication.
- D. Check fan wheel clearances and fan alignment.
- E. Check motor security to mounting base.
- F. Check alignment of drive.
- G. Check vibration isolator adjustment.

- H. Verify that proper filter media is installed.
- I. Verify that all control dampers are installed and operable without binding or sticking.
- J. Confirm that all fire, smoke and volume dampers are installed and in full open position.
- K. Verify that all air terminal units are installed.
- L. Confirm that all air openings in walls above ceilings have been provided.
- M. Check for and repair all excessive air leaks in duct systems, at equipment connections and at coils.
- N. Air leaks shall not exceed SMACNA parameters for system pressure.
- O. Verify that ductwork is constructed and installed in accordance with contract drawings and/or approved ductwork shop drawings.
- P. Inspect and clean all coils (including evaporator and condenser) and correct fin damage.

### 3.5. AIR SIDE TESTING AND BALANCING

#### A. GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

1. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
2. Prepare schematic diagrams of systems' "as-built" duct layouts.
3. For variable-air-volume systems, develop a plan to simulate diversity.
4. The TAB contractor shall cycle each air handling unit through its control sequence of operation to verify proper operation. Any inconsistency with contract documents shall be reported to A/E and temperature control contractor. Temperature control contractor shall take prompt action to correct any control inconsistency as reported by the TAB contractor.
5. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
6. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
7. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
8. Verify that motor starters are equipped with properly sized thermal protection.
9. Check dampers for proper position to achieve desired airflow path.
10. Check for airflow blockages.
11. Check condensate drains for proper connections and functioning.
12. Check for proper sealing of air-handling-unit components.
13. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

#### B. PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

1. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - a. Measure total airflow.
    - i. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  - b. Measure fan static pressures as follows to determine actual static pressure:
    - i. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - ii. Measure static pressure directly at the fan outlet or through the flexible connection.
    - iii. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    - iv. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - c. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - i. Report the cleanliness status of filters and the time static pressures are measured.
  - d. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
  - e. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

- f. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  - g. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
2. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
- a. Measure airflow of submain and branch ducts.
    - i. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  - b. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
  - c. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
3. Measure air outlets and inlets without making adjustments.
- a. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
4. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
- a. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  - b. Adjust patterns of adjustable outlets for proper distribution without drafts.

### C. PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

1. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
2. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
- a. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
  - b. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
  - c. Measure total system airflow. Adjust to within indicated airflow.
  - d. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
  - e. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
    - i. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
  - f. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    - i. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

- g. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
- h. Record final fan-performance data.

3. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

- a. Balance variable-air-volume systems the same as described for constant-volume air systems.
- b. Set terminal units and supply fan at full-airflow condition.
- c. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
- d. Readjust fan airflow for final maximum readings.
- e. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
- f. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
- g. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
  - i. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
- h. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
  - i. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

4. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

- a. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- b. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
- c. Set terminal units at full-airflow condition.
- d. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
- e. Adjust terminal units for minimum airflow.
- f. Measure static pressure at the sensor.
- g. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

#### D. PROCEDURES FOR HEAT-TRANSFER COILS

1. Measure, adjust, and record the following data for each electric heating coil:

- a. Nameplate data.
- b. Airflow.
- c. Entering- and leaving-air temperature at full load.
- d. Voltage and amperage input of each phase at full load and at each incremental stage.
- e. Calculated kilowatt at full load.
- f. Fuse or circuit-breaker rating for overload protection.

2. Measure, adjust, and record the following data for each refrigerant coil:

- a. Dry-bulb temperature of entering and leaving air.
- b. Wet-bulb temperature of entering and leaving air.
- c. Airflow.
- d. Air pressure drop.
- e. Refrigerant suction pressure and temperature.

### 3.6. PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

### 3.7. PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

### 3.8. PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

### 3.9. TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10% percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

### 3.10. REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in

"Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.11. FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

- 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

- 2. Include a list of instruments used for procedures, along with proof of calibration.

- B. Final Report Contents: In addition to certified field-report data, include the following:

- 1. Pump curves.

- 2. Fan curves.

- 3. Manufacturers' test data.

- 4. Field test reports prepared by system and equipment installers.

- 5. Other information relative to equipment performance; do not include Shop Drawings and product data.

- C. General Report Data: In addition to form titles and entries, include the following data:

- 1. Title page.

- 2. Name and address of the TAB contractor.

- 3. Project name.

- 4. Project location.

- 5. Architect's name and address.

- 6. Engineer's name and address.

- 7. Contractor's name and address.

- 8. Report date.

- 9. Signature of TAB supervisor who certifies the report.

- 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

- 11. Summary of contents including the following:

- a. Indicated versus final performance.

- b. Notable characteristics of systems.

- c. Description of system operation sequence if it varies from the Contract Documents.

- 12. Nomenclature sheets for each item of equipment.

- 13. Data for terminal units, including manufacturer's name, type, size, and fittings.

- 14. Notes to explain why certain final data in the body of reports vary from indicated values.

- 15. Test conditions for fans and pump performance forms including the following:

- a. Settings for outdoor-, return-, and exhaust-air dampers.

- b. Conditions of filters.

- c. Cooling coil, wet- and dry-bulb conditions.

- d. Face and bypass damper settings at coils.

- e. Fan drive settings including settings and percentage of maximum pitch diameter.

- f. Inlet vane settings for variable-air-volume systems.

- g. Settings for supply-air, static-pressure controller.

- h. Other system operating conditions that affect performance.

- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

- 1. Quantities of outdoor, supply, return, and exhaust airflows.

- 2. Water and steam flow rates.

- 3. Duct, outlet, and inlet sizes.

- 4. Pipe and valve sizes and locations.

- 5. Terminal units.

- 6. Balancing stations.

- 7. Position of balancing devices.

3.12. ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

3.13. AIR AND WATER BALANCE CONSTRUCTION COORDINATION

- A. During installation of the mechanical systems the testing and balancing contractor shall make no less than (3) inspection visits to the project site. Proper placement and installation of all control and balancing devices shall be verified by these inspections. The mechanical contractor shall make all corrections in control and balancing device locations as requested by the TAB contractor. Following each inspection visit the TAB contractor shall report to the A/E all items noted, action taken, and progress of control device installation. The last inspection and balancing shall be performed in the presence of a professional engineer active in the design of mechanical building systems.

**END OF SECTION 230593**

## SECTION 230713 – DUCT INSULATION

### PART 1 - GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 230010.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. SUMMARY

- A. Section Includes:
  - 1. Insulation Materials:
    - a. Flexible elastomeric.
    - b. Mineral fiber.
  - 2. Insulating cements.
  - 3. Adhesives.
  - 4. Mastics.
  - 5. Sealants.
  - 6. Factory-applied jackets.
  - 7. Field-applied jackets.
  - 8. Tapes.

#### 1.3. SUBMITTALS

- 1. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- 2. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

#### B. QUALITY ASSURANCE

- 1. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
  - a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - b. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- 2. Products shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or polybrominated diphenyl ether fire retardants.

#### 1.4. DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.5. COORDINATION

- A. Coordinate clearance requirements with duct Installer for duct insulation application and equipment Installer for equipment insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- B. All ductwork shall be provided with insulation meeting the requirements of the energy code for exterior and interior requirements. All ductwork shall be insulated to prevent condensation.
- C. Refer to insulation schedule for additional information in addition to these requirements.
- D. All exterior insulation shall be provided with a jacket.

### PART 2 PRODUCTS

#### 2.1. INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.



- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

## 2.2. DUCT LINER

- A. Fibrous-Glass Duct Liner (Flat Applications): Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Knauf Insulation; Atmosphere Duct Liner with ECOSE Technology
    - b. CertainTeed Corporation; Insulation Group.
    - c. Johns Manville.
    - d. Owens Corning.
    - e. Manson Insulation; Akousti-Liner Duct Liner with ECOSE Technology.
  - 2. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
    - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
  - 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  - 4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- B. Fibrous-Glass Duct Liner (Round Applications): Engineered, pre-formed insulation designed for specific duct diameters and fittings. Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard." Rigid, resin bonded fibrous glass board with a damage-resistant, flame retardant veil faced airstream surface with a reinforced aluminum foil (FRK) backing.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Knauf Insulation; Atmosphere Duct Liner with ECOSE Technology
    - b. CertainTeed Corporation; Insulation Group.
    - c. Johns Manville.
    - d. Owens Corning.
    - e. Manson Insulation; Akousti-Liner Duct Liner with ECOSE Technology.
  - 2. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
  - 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  - 4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- C. Fiber-Free Duct Liner (Flat Applications): Polyester blanket insulation with FSK facing. Comply with ASTM C 1071, NFPA 90A, or NFPA 90B.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ductmate.
  - 2. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
  - 3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
  - 4. Duct liner shall be an engineered nonwoven, thermally bonded Polyester with a smooth and durable FSK facing. Liner must have a noise reduction coefficient of at least 0.65 and have thermal values greater or equal to an R-4.2 at 1", R-5 at 1.25", R-6 at 1 Yi" and R-8 at 2" respectively.
  - 5. Polyester liner must be able to withstand a constant internal temperature up to 250°F must be compliant with Greenguard Environmental Institute, and contain zero VOCs per ASTM D5116. Liner must comply with all applicable standards including ASTM E84, ASTM C518, ASTM G-21, NFPA 90A and 90B, and UL 181.
  - 6. Polyester duct liner must be attached using a non-flammable, low VOC water based lagging adhesive. When applicable, apply a non-flammable, low VOC water based lagging adhesive to the exposed leading edge of the insulation. Install fasteners per SMACNA HV AC Duct Liner installation instructions. Liner must consist of at least 25% recycled content.
  - 7. Polyester duct liner must be installed per section 7.4 of the 2005 SMACNA Manual, "HVAC Duct Construction Standards, Metal and Flexible," Third Edition unless otherwise specified

D. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 1534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Aeroflex USA Inc.
  - b. Armacell LLC.
  - c. Rubatex International, LLC
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

### 2.3. DUCT WRAP

A. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. 1.0 lb. density standard duct insulation type IV with foil-scrim-craft facing and .27 BTUH thermal conductivity at 75 degrees mean temperature.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. CertainTeed Corp.; Duct Wrap.
  - b. Johns Manville; Microlite.
  - c. Knauf Insulation; Atmosphere Duct Wrap with ECOSE Technology (Basis of Design Product).
  - d. Manson Insulation Inc.; Alley Wrap B with ECOSE Technology.
  - e. Owens Corning; All-Service Duct Wrap.

B. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. CertainTeed Corp.; Commercial Board.
  - b. Johns Manville; 800 Series Spin-Glas.
  - c. Knauf Insulation; Earthwool Insulation Board with ECOSE Technology (Basis of Design Product).
  - d. Manson Insulation Inc.; AK Board with ECOSE Technology.
  - e. Owens Corning; Fiberglas 700 Series.

C. Flexible Elastomeric Duct Wrap: Closed cell insulation with a 16 mil laminated covering membrane (a UV protective white or silver, blended polymeric top surface and a puncture-resistant blended polymeric base, around a scrim reinforced core). The membrane has a 10-year limited warranty against breakdown due to UV radiation. Mold-resistant flexible elastomeric thermal insulation. It is manufactured without the use of CFCs, HFCs or HCFCs.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armacell LLC ArmaTuff Plus II.
2. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

### D. Fire-Rated Insulation Systems

1. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
2. Products: Subject to compliance with requirements, provide one of the following:

- a. CertainTeed Corp.; FlameChek.
- b. Johns Manville; Firetemp Wrap.
- c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
- d. Thermal Ceramics; FireMaster Duct Wrap.
- e. 3M; Fire Barrier Wrap Products.
- f. Unifrax Corporation; FyreWrap.
- g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

E. Insulation Pins and Washers:

- a. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

F. SOUND LAGGING

- 1. For all HVAC equipment greater than 4000 cfm provide sound lagging for all vertical ductwork up or down to unit and also for the next horizontal 10 feet of ductwork. Also provide lagging where called for on plans.
- 2. System shall provide SoundSeal Barricade Lag Series loaded vinyl noise barrier with fibrous glass scrim reinforced aluminum foil facing on one side. The reinforced foil facing shall accept matching tape for quick and easy installation.
- 3. Where external thermal insulation is specified provide Soundseal B-10 LAG (1#/sf) over the thermal insulation. Where exterior thermal insulation is not specified provide 2" thick Soundseal B-10 LAG/QFA-9 (1#/sf and 0.4#/sf) lagging with quilted fiberglass decoupler on the back of the product to form a tight fitting "floating" noise barrier.
- 4. Sound transmission coefficient (STC) shall be 26 or 30 for the installed system.

Sound Transmission Loss (dB) Frequency (Hz)							
	125	250	500	1000	2000	4000	STC
B-10 LAG	15	16	21	26	33	38	26
B-10 LAG/QFA-9	19	20	23	33	44	53	30

5. Meets Class A flammability rating per ASTM E-84

2.4. INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.5. ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
1. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.6. MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
  - B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 200 deg F.
3. Solids Content: 63 percent by volume and 73 percent by weight.
4. Color: White.

2.7. SEALANTS

- A. Joint Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.

3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8. FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.9. FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. See Division 01 Section "Product Requirements."
2. Factory cut and rolled to size.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
6. Factory-Fabricated Fitting Covers:
  - a. Same material, finish, and thickness as jacket.
  - b. End caps.
  - c. Beveled collars.
  - d. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10. TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

PART 3 – EXECUTION

3.1. EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2. PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3. INSULATION SCHEDULE

- A. Refer to drawings for insulation and ductwork schedule.

### 3.4. GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
    - J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
    - K. Install insulation with factory-applied jackets as follows:
      - 1. Draw jacket tight and smooth.
      - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
      - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      - 4. For below ambient services, apply vapor-barrier mastic over staples.
      - 5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
      - 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
        - L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
        - M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
        - N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
        - O. For above ambient services, do not install insulation to the following:
          - 1. Vibration-control devices.
          - 2. Testing agency labels and stamps.
          - 3. Nameplates and data plates.
          - 4. Access doors.
- P. Undamaged insulation systems on cold surface ductwork and equipment shall perform their intended functions as vapor barriers and thermal insulation without premature deterioration of insulation or vapor barrier. Contractor shall take every reasonable precaution to provide insulation systems with continuous unbroken vapor barriers.
- Q. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and

Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. For double wall ductwork, secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
  - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

### 3.5. PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
  - B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Penetration Firestopping and fire-resistive joint sealers.
    - C. Insulation Installation at Floor Penetrations:
      1. Pipe: Install insulation continuously through floor penetrations.
      2. Seal penetrations through fire-rated assemblies. Comply with requirements in Penetration Firestopping."

### 3.6. MINERAL-FIBER INSULATION INSTALLATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
  1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Impale insulation over pins and attach speed washers.
    - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- B. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples,

1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

1. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
2. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

- C. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
- D. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- E. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
- b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
- c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
- d. Do not overcompress insulation during installation.
- e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
- b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.7. FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.8. EXTERIOR FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. install using manufacturer recommended adhesives or with pre-applied pressure sensitive adhesive (PSA) for application to large, flat or curved metal surfaces such as ducts, vessels, very large pipes or tanks.
- B. The seams must be installed in compression and sealed with adhesives. Adhesives are contact adhesives and shall be applied to duct and insulation surfaces.
- C. Cover seams with manufactured Seal Tape specific for application matching jacket.
- D. Exterior duct work must be pitched to allow rain water to run off the insulation.
- E. Do not install below ground.

F. The application temperature should be above 40°F (+4°C) and 100°F (+38°C).

### 3.9. FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

### 3.10. FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.11. FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
- E. Insulation failing to meet workmanship and appearance standards shall be replaced with an acceptable installation before final acceptance of project will be given. Insulation failing to meet performance requirements of this specification for a period of one year after date of final acceptance or through one heating season and one cooling season, whichever is longer shall be replaced with an acceptable installation. All costs to correct insulation deficiencies and costs to repair damages to other work shall be at Mechanical Contractors expense at no cost to owner.

### 3.12. FIELD QUALITY ASSURANCE

- A. Upon completion of insulation work and before operation is to commence, visually inspect the work and verify that it has been correctly installed.
- B. Open all system dampers and turn on fans to blow all scraps and other loose pieces of material out of the duct system. Allow for a means of removal of such material.
- C. Check the duct system to ensure that there are no air leaks through joints.

### 3.13. PROTECTION

- A. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with duct liner damage and moisture-saturated insulation.
- B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and



deterioration of the finished insulation work.

**END OF SECTION 230713**

## SECTION 230923 – AUTOMATIC TEMPERATURE CONTROLS

### PART 1 GENERAL

#### 1.1. SUBMITTALS

- A. Product Data: For each control device indicated.
- B. Shop Drawings:
  - 1. Schematic flow diagrams.
  - 2. Power, signal, and control wiring diagrams.
  - 3. Details of control panel faces.
  - 4. Damper schedule.
  - 5. Valve schedule.
  - 6. DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
  - 7. Control System Software: Schematic diagrams, written descriptions, and points list and screen graphics.
- C. Software and firmware operational documentation.
- D. Field quality-control test reports.
- E. Operation and maintenance data.

### PART 2 PRODUCTS

#### 2.1. MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

#### 2.2. CONTROL SYSTEM

- A. Manufacturers:
  - 1. Schneider Electric by CNC Group. – Contact Jake Walters with CNC Group at (913.529.6271)
- B. Control system and components shall be backward compatible and utilize and support open protocols. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- C. Control system and components shall be backward compatible and utilize and support open protocols. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

#### 2.3. DDC EQUIPMENT

- A. Operator Workstation: PC-based microcomputer with minimum configuration as follows:
  - 1. Motherboard: With min 6 USB 3.0 ports, Gigabit Ethernet.
  - 2. Processor: Intel Core i5, 3.5GHz, quad core minimum..
  - 3. Random-Access Memory: 8 GB min.
  - 4. Graphics: Video adapter, with hdmi, vga as required to mate to monitor.
  - 5. Monitor: 23 inches, LED.
  - 6. Keyboard: Standard keyboard with number pad, USB.
  - 7. Hard-Disk Drive: 500 GB min solid state.
  - 8. Mouse: USB standard type.
  - 9. Uninterruptible Power Supply: 2 kVa.
  - 10. Operating System: Microsoft Windows 7 Professional or 10 Professional.
- B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
  - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation.
  - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.
    - b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.

- d. Software applications, scheduling, and alarm processing.
  - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
- C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
  2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.
    - b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.
  3. Local operator interface provides for download from or upload to operator workstation.
- D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
  2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
  3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
  4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.
  5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
  6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
  7. Universal I/Os: Provide software selectable binary or analog outputs.
- E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
  2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
  3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
  2. Maximum response time of 10 nanoseconds.
  3. Minimum transverse-mode noise attenuation of 65 dB.
  4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

#### 2.4. UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
  2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.
  3. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

#### 2.5. ANALOG CONTROLLERS

1. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
2. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.
3. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
  - a. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

## 2.6. ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Accuracy: Plus or minus 0.5 deg F at calibration point.
- C. Wire: Twisted, shielded-pair cable.
- D. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
- E. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft..
- F. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
- G. Room Sensor Cover Construction: Manufacturer's standard locking covers.
- H. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- I. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- J. RTDs and Transmitters:
  - 1. Accuracy: Plus or minus 0.2 percent at calibration point.
  - 2. Wire: Twisted, shielded-pair cable.
  - 3. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
  - 4. Averaging Elements in Ducts: use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
  - 5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
  - 6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - 7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
  - 8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- K. Humidity Sensors: Bulk polymer sensor element.
  - 1. Accuracy: [5] [2] percent full range with linear output.
  - 2. Room Sensor Range: 20 to 80 percent relative humidity.
  - 3. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - 4. First five subparagraphs below are optional features.
  - 5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
  - 6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F.
  - 7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
- L. Pressure Transmitters/Transducers:
  - 1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
  - 2. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
  - 3. Output: 4 to 20 mA.
  - 4. Building Static-Pressure Range: 0- to 0.25-inch wg.
  - 5. Duct Static-Pressure Range: 0- to 5-inch wg.
  - 6. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
  - 7. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
  - 8. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
  - 9. Pressure Transmitters: Direct acting for gas or liquid service; range suitable for system; linear output 4 to 20 mA.

## 2.7. STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

## 2.8. GAS DETECTION EQUIPMENT

- A. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output, for wall mounting.
- B. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

## 2.9. ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
  - B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
  2. Dampers: Size for running torque.
  3. Coupling: V-bolt and V-shaped, toothed cradle.
  4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
  6. Power Requirements (Two-Position Spring Return): 24-V ac.
  7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
  8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  9. Temperature Rating: Minus 22 to plus 122 deg F.

## 2.10. CONTROL VALVES

- A. Manufacturers:
  1. Danfoss Inc.; Air Conditioning & Refrigeration Div.
  2. Hayward Industrial Products, Inc.
  3. Magnatrol Valve Corporation.
  4. Neles-Jamesbury.
  5. Parker Hannifin Corporation; Skinner Valve Division.
  6. Sauter Controls Corporation.
- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Hydronic system globe valves shall have the following characteristics:
  1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
  2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
  3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
    - a. Retain one or both subparagraphs below.
    - b. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    - c. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
  4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
    - a. Two Position: Line size.
    - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
  5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
  6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off

pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

- D. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
  - 1. Disc Type: Elastomer-coated ductile iron.
  - 2. Sizing: 1-psig maximum pressure drop at design flow rate.
- E. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
  - 1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
  - 2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
  - 3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

#### F. DAMPERS

- 1. Provide all automatic dampers except for any specified to be provided under the individual HVAC unit specifications. Dampers for control of outside air and relief air shall be Ruskin CD-50 or equal, extruded aluminum, low leakage, parallel blade design with nylon bearings and blade and frame seals on all mating surfaces. Damper leakage shall not exceed 6 CFM per square foot at 4.0" water column, tested in accordance with AMA Standard 500. All other control dampers shall be Ruskin CD-35 or equal with 16 gauge steel blades, steel channel frame, oilite bearings, cadmium plated shafts and blade and jamb seals. Sectionalize outside air dampers as required to accurately provide the minimum outside air cfm, independent of the maximum outside air dampers.

### PART 3 EXECUTION

#### 3.1. INSTALLATION

- A. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install adjustable devices 48 inches above the floor.
- B. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- C. Install guards on thermostats in the following locations:
  - 1. Entrances.
  - 2. Public areas.
  - 3. Where indicated.
- D. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- G. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- H. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- I. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

#### 3.2. PANEL AND DEVICE LOCATIONS

- A. Coordinate all control cabinets and other wall mounted controllers with other trades.
- B. Panels and cabinets shall be located in mechanical spaces and other ancillary use spaces such as storage rooms. These locations shall be submitted and approved as part of the submittal process.
- C. Do not locate control cabinets in spaces dedicated to other uses such as IT closets, data rooms, chases, etc without prior approval.

#### 3.3. ELECTRICAL POWER WIRING PROVISIONS

- A. Provide a 20A/1P 120 or 277 volt circuit from the nearest panelboard related to the work for miscellaneous HVAC control system power. Contractor may provide multiple circuits at their option. Utilize spare circuit breakers or provide new when one is not available.
- B. Coordinate with mechanical equipment specifics and contractors proposed method of control power provisions. All work shall comply with Division 26 requirements and latest adopted version of the National Electric Code.
- C. Provide all necessary line voltage wiring and connections for control equipment, power supplies, dampers, actuators, and other items requiring line voltage power. This work shall be coordinated with other trades and shall be in conformance with other portions of this contract and requirements.

### 3.4. ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
  - B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
  - C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
1. Install exposed cable in raceway, including mechanical rooms, at wall mounted control cabinets and any location control wiring would be exposed to view or damage. Exposed raceway in finished spaces shall be wiremold or similar appearing material and painted if required by the finish of the room.
  2. Install concealed cable in walls and other non-accessible spaces in raceway. Wall mounted devices shall be provided with backbox and conduit.
  3. Install cable in accessible plenums as plenum rated and properly supported.
  4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
    - D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
    - E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

### 3.5. FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
  2. Test and adjust controls and safeties.
  3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
  4. Test each point through its full operating range to verify that safety and operating control set points are as required.
  5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
  6. Test each system for compliance with sequence of operation.
  7. Test software and hardware interlocks.

### 3.6. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
9. Check DDC system as follows:
  - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
  - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
  - c. Verify that spare I/O capacity has been provided.
  - d. Verify that DDC controllers are protected from power supply surges.
10. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

### 3.7. DEMONSTRATION

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate,

and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

### 3.8. TRAINING

1. Provide a minimum of 4 classroom training sessions, 4 hours each, for personnel designated by the Owner.
2. Train the designated staff of Owner's representative and Owner to enable them to proficiently operate the system; create, modify and delete programming; add, remove and modify physical points for the system; add additional panels when required.
3. Provide one copy of training material per student.
4. The instructors shall be factory-trained instructors experienced in presenting this material.
5. Classroom training shall be done using a network of working controllers representative of the installed hardware or at the customers site.
6. At such time acceptable performance of the system hardware and software has been established, the Temperature Control Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent Temperature Control Contractor's representative familiar with the system's software, hardware and accessories.
7. The Temperature Control Contractor shall give instruction to the Owner's personnel on the operation of all equipment within the building and describe its intended use with respect to the programmed functions specified. Operator orientation of the system shall include, but not be limited to, the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, system generation, advisories, and appropriate operator intervention required in responding to the system's operation.
8. The Temperature Control Contractor shall give web based access with temporary log-in and password to design engineer for the period of one year from substantial completion.

### 3.9. TESTING AND BALANCING COORDINATION

1. The temperature control contractor shall have a technical representative present with the balancing contractor on the first day of balancing for a minimum of four hours of active balancing and temperature controls coordination.
2. For the remainder of the balancing the temperature contractor may either have a technical representative present, or may furnish the balancer with the latest DDC software and all required interface devices. This includes instructions and coordination in the use of all interface devices, including laptop computers. There shall be no charge to the balancing contractor for the use of these interface devices and they shall be returned to the temperature controls contractor at the end of the balancing process.

**END OF SECTION 230923**



## SECTION 232000 – HVAC PIPING

### PART 1 - GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 230010.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. SUBMITTALS

- A. Product Data: For each type of product to be used.

### PART 2 - PRODUCTS

#### 2.1. PIPING MATERIALS

- A. Piping used throughout project shall conform to the following specifications. Piping shall be plainly marked with manufacturers name and weight. See piping material schedule on the drawings for materials to be used for each piping system.
1. Carbon Steel Pipe (1/8" thru 2"):
    - a. Provide seamless carbon steel conforming to ASTM specification A-106.
    - b. Pipe joints shall be threaded conforming to ANSI Standard B2.1.
    - c. Pipe by Armco, Jones, Laughlin Steel Corp., Youngstown Sheet and Tube Co., or United States Steel.
  2. Carbon Steel Pipe (2-1/2" and above):
    - a. Provide electric resistance welded carbon steel pipe conforming to ASTM Specification A-53.
    - b. Pipe ends shall be beveled for welding.
    - c. Pipe by Armco, Jones and Laughlin Steel Corp., Youngstown Sheet and Tube Co., or United States Steel.
  3. Copper Tube:
    - a. Provide hard temper copper water tube conforming to requirements of current ASTM Specification B-88. Tubing shall be Type K, L, or M as listed in schedule. Tubing joints shall be soldered or brazed. See schedule for joining method to be used.
    - b. Pipe by Anaconda, Cerro, Chase, Mueller or Revere Copper.
  4. Copper Tube Type ACR:
    - a. Provide hard temper nitrogenized copper refrigerant tube conforming to requirements of current ASTM B-88. Tubes shall be Type L or K as listed in schedule.
    - b. Tubing joints shall be brazed.
    - c. Pipe by Anaconda, Cerro, or Mueller.
  5. Polyvinyl Chloride Drain Waste Pipe:
    - a. Provide Schedule 40 polyvinyl chloride solid core plastic drain waste and vent pipe conforming to ASTM D2665. Joints shall be properly cleaned, primed and glued where scheduled.
    - b. Polyvinyl Chloride (PVC) Pipe & Fittings Cell Class 12454 B.
      - i. ASTM D 2241 SDR-26
    - c. Pipe by Charlot, Genova, Crestline or equal.
  6. Polyethylene Pipe GSHP Piping:
    - a. Provide polyethylene pipe for ground source heat pump service. Pipe shall be UV stabilized.
    - b. SDR 11 160 psi water at 73°F (standard) or SDR 9 200 psi water at 73°F (special order) for deep installations or high static pressures.
    - c. DriscoPlex™ 5300 Climate Guard® pipe, molded fittings and fabricated fittings are manufactured from high-density, high molecular weight PE 3408 polyethylene compound that meets or exceeds ASTM D 3350 cell classification 345464C, and is listed by the Plastic Pipe Institute in PPI TR-4 with HDB ratings of 1600 psi (11.04 MPa) at 73°F (23°C) and 800 psi (5.52 MPa) at 140°F (60°C). DriscoPlex™ 5300 Climate Guard® pipe is manufactured in accordance with ASTM D 3035. Molded fittings are manufactured in accordance with ASTM D 3261 (butt outlet) and ASTM D 2683 (socket outlet).

- d. Secure Joining DriscoPlex™ 5300 Climate Guard® pipe and fittings are quickly joined by socket, butt or saddle heat fusion, electrofusion, or mechanical fittings. Climate Guard® 5300 mechanical connection fittings are available for joining to other materials or to itself. Suitable electrofusion fittings may also be used.
  - e. Provide Pre-Fused Polyethylene U-Bend with anchor wings for anchoring bottom of loop.
7. Below Grade Pre-Insulated Chilled Water Piping:
- a. Provide Wirsbo Ecoflex Thermo Single cross-linked polyethylene piping for below grade chilled water piping from the building to the chiller. Provide a PVC pipe long sweep pipe sleeve at the chiller cast into the chiller pad for this piping. Above grade convert to copper piping.
  - b. Equivalents: Perma-Pipe poly-therm PVC, Thermal Pipe Systems, Inc. Kool-Kore PVC or equal.
8. Pre-Insulated Underground Chilled Water Pipe:
- a. Piping shall be PVC Class 160 or 200 conforming to the requirements of ASTM D-2241 by Perma-Pipe/Ricwil Chil-Gard system composed of integral sealed units of PVC outer jacket, PVC service pipe and insulated with polyurethane foam, completely filling the annular space between the pipe and jacket. Jacket ends shall be protected with a factory applied moisture barrier. Jacket shall be ASTM 1784 PVC with a minimum wall thickness of .06 inches.
  - b. Alternate manufacturers may be Insul-Tek or Rovanco.
  - c. Insulation for below grade pre-insulated chilled water piping shall be Polyurethane foam insulation that completely fills the annular space between the service pipe and the outer jacket and has the lowest thermal conductivity of all commercial insulation .16 Btu-in/hr-ft<sup>2</sup>-F. The insulation shall be a nominal 2.0 lb/ft<sup>3</sup> density and 90% closed cell structure, providing a high resistance to water absorption.
  - d. The pre-insulated chilled water piping shall be installed specifically as directed by the manufacturer. Thrust blocks are required at changes in direction and size. Completely restrain the piping system before testing and operation.
9. Modular Aluminum Piping
- a. Pipe
    - i. ¾" – 6"
    - ii. 190 psi working pressure
    - iii. Working temperatures: 0 Deg F to 140 Deg F
    - iv. Compatible with all types of compressor lubricants -compressed air, vacuum, inert gas
    - v. Conforms to ASME B31.1
    - vi. Fire resistant to flammability standard UL94HB
    - vii. OSHA Compliant
    - viii. Color: Blue (RAL 5012)
  - b. Fittings
    - i. Bite ring: stainless steel
    - ii. DieCast Aluminum Alloy
    - iii. o-ring: Nitrile -Electrocoated
    - iv. Provide clamps, unions, valves, fittings, manifolds, quick drops, gauges of same modular system.

## 2.2. PIPING FITTINGS

- A. Piping fitting used throughout project shall be proper type for installation method used and shall be compatible with piping system material. Fittings listed in piping material schedule shall conform to the following specifications:
1. Carbon Steel Welding Fittings:
    - a. Provide carbon low alloy seamless steel welding fittings conforming to current ANSI Standard B16.9 and ASTM Specification A234.
    - b. Fittings by Grinnell, Midwest or Tube Turn.
  2. Branch Connection Welding Fittings:
    - a. Provide carbon steel weldolet fittings conforming to ANSI Standards B16.9, B16.11, B31.1.0 and ASTM specification A105, Grade 11.
    - b. Fittings by Bonney Forge.
  3. Branch Connection, Welding to Screwed Fitting:

- a. Provide carbon steel threadolet fitting conforming to ANSI Standards B16.9, B16.11, B31.1, and ASTM Specification A105, Grade 11.
  - b. Fittings by Bonney Forge.
- 4. Carbon Steel Flanges:
  - a. Provide carbon steel flanges conforming to ASTM Specification A181, Grade 1, and ANSI Standard B16.5.
  - b. Flanges by Babcock and Wilcox, Grinnell, Midwest or Tube Turn.
- 5. Malleable Iron Screwed Fittings:
  - a. Provide screwed malleable iron fittings conforming to ANSI Standard B16.3, and ASTM Specification A-47 grade 32510.
  - b. Fittings by Crane, Grinnell or Stockham.
- 6. Cast Iron Screwed Fittings:
  - a. Provide screwed cast iron fittings conforming to ANSI Standard B16.4, B2.1, and ASTM Specification A-126, Class A.
  - b. Fittings by Crane, Grinnell or Stockham.
- 7. Wrought Copper Fittings:
  - a. Provide wrought solder joint copper tube fitting conforming to ANSI Standard B16.22
  - b. Fittings by Anaconda, Chase or Nibco.
- 8. Cast Bronze Fittings:
  - a. Provide cast bronze solder joint fittings conforming to ANSI Standard B16.18.
  - b. Fittings by Anaconda, Chase or Nibco.
- 9. Pipe Flange Gaskets:
  - a. Provide 1/16" thick asbestos free gaskets full face or ring type as required. Gaskets shall be factory cut.
  - b. Gaskets by Durable Mfg. Co. or Garlock Company.
- 10. Roll Grooved Pipe Couplings:
  - a. Provide Victaulic style #07 or approved equal style (zero flex) couplings with Grade "E" gasket (EPDM compound) in mechanical areas. Provide Victaulic style #77 or approved equal style (flexible) couplings with Grade "E" gasket in other areas. Provide with ductile iron housing and nuts and bolts.
  - b. Equivalent by Grinnell.
- 11. PVC Fittings:
  - i. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe. PVC Non-pressure Piping Joints: Join piping according to ASTM D 2665.
    - ii. Joints shall be of a push-on type with a bell-end grooved to receive a synthetic rubber gasket when scheduled. Solvent welded joints are not allowed outside the building. The joint shall be made in accordance with ASTM D 3212.
  - b. Equivalents: Spears, Lasco or equal.
- 12. Pre-Insulated Underground Chilled Water Fittings:
  - a. Fittings shall be PVC Class 160 or 200 conforming to the requirements of ASTM D-2241 by Perma-Pipe/Ricwil Chil-Gard system composed of integral sealed units of PVC outer jacket, Fittings shall be joined with integral bell and spigot joints, including a rubber sealing ring.

### PART 3 - EXECUTION

#### 3.1. PIPING INSTALLATION

A. Piping systems materials and installation shall conform to the following standards and codes.

- 1. System: Heating and Air Conditioning Piping
  - a. Code: ANSI Standard B31.1.0 "Power Piping"

- B. No piping containing water shall be located in areas subject to freezing temperatures, including: unheated attics, unheated plenums, chases wall spaces or cavities within exterior walls, under slabs, or in concrete.
- C. Pipe sizes indicated on plans and as specified refer to nominal size in inches, unless otherwise indicated. Pipes are sized to nearest ½". In no case shall piping smaller than size specified be used.
- D. Contractor shall provide and be responsible for proper location of pipe sleeves, hangers, supports, and inserts. Install hangers, supports, inserts, etc., as recommended by manufacturer and as specified and detailed on drawings.
- E. Verify construction types and provide proper hangers, inserts and supports for construction used. Install inserts, hangers and supports in accordance with manufacturers load ratings and provide for thermal expansion of piping without exceeding allowable stress on piping or supports. Provide solid type hangers and supports where pipe travel exceeds manufacturer's recommendations for fixed hanger and supports.
- F. Install piping parallel with building lines and parallel with other piping to obtain a neat and orderly appearance of piping system. Secure piping with approved anchors and provide guides where required to insure proper direction of piping expansion. Piping shall be installed so that allowable stress for piping, valves and fittings used are not exceeded during normal operation or testing of piping system.
- G. Install piping so that systems can be completely drained. Provide piping systems with valve drain connections at all low pipe and ahead of all sectionalizing valves whether shown on plans or not. Drain lines shall be ¾".
- H. Drain valves on closed piping systems such as chilled water system shall have lock shields and plugged or capped outlets to protect system from inadvertent drainage.
- I. Pitch all piping and where possible make connections from horizontal piping so that air can be properly vented from system. Provide air vents as specified at all system high points and at drop in piping in direction of flow. Use eccentric reducers where necessary to avoid air pockets in horizontal piping.
- J. Provide unions or flanged joints in each pipe line preceding connections to equipment to allow removal for repair or replacement. Provide all screwed and control valves with unions adjacent to each piping connection. Provide screwed end valves with union adjacent to valve unless valve can be otherwise easily removed from line.
- K. Fittings pressures and temperature ratings shall be equal to or exceed maximum operating temperature and working pressure of piping system. No mitered or field fabricated pipe fittings will be permitted.
- L. All pipe threads shall meet ANSI Standard B2.1 for taper pipe threads. Lubricate pipe threads with Teflon thread sealant and lubricating compound applied full strength. Powdered or made-up compound will not be permitted. Pipe thread compound shall be applied only to male pipe threads.
- M. Brazed socket type joints shall be made with suitable brazing alloys. Minimum socket depth shall be sufficient for intended service. Brazing alloy shall be end fed into socket, and shall fill completely annular clearance between socket and pipe or tube. Brazed joints depending solely upon a fillet rather than a socket type joint will not be acceptable.
- N. Soft soldered socket type joints shall be made with sill-floss or 95-5 tin-antimony solder as required by temperature and pressure rating of piping system. Soldered socket-type joints shall be limited to systems containing non-flammable and non-toxic fluids. Soldered socket-type joints shall not be used on piping systems subject to shock vibration. Soldered joints depending solely upon a fillet rather than a socket-type joint will not be acceptable.
- O. Make changes in piping size and direction with approved factory made fittings. Provide fittings suitable for at least 125 PSI working pressure or of pressure rating required for maximum working pressure of system whichever is greater.

### 3.2. PIPING SUPPORTS, ANCHORS, SLEEVES AND SEALS

- A. Furnish proper type and size pipe sleeves to General Contractor for installation in concrete or masonry walls or floors. Sleeves are not required for supply and waste piping through wall supporting plumbing fixtures or for cast iron soil pipe passing through concrete slab or grade except where penetrating a membrane waterproof floor.
- B. Mechanical Contractor shall supervise installation of sleeves to insure proper location and installation.
- C. Each sleeve shall be continuous through wall floor or roof and shall be cut flush on each side except where indicated otherwise. Sleeves shall not be installed in structural member except where indicated or approved.
- D. Sleeves passing through above grade floors subject to flooding such as toilet rooms, bathrooms, equipment rooms and kitchens shall be cast iron with integral flanges and shall extend 1 inch above finished floor. Size sleeves for and seal space between pipe sleeve with Thunderline Link-Seal.
- E. Provide steel pipe sleeves in bearing walls and masonry walls. Opening in non-bearing walls, floors and ceilings may be 20 gauge galvanized pipe sleeves or openings cut with concrete core drill.
- F. Pipe insulation shall run continuous through pipe sleeves with ¼" minimum clearance between insulation and pipe sleeve. Provide metal jackets over insulated pipes passing through fire walls, floors and smoke partitions. Jacket shall be 0.018 stainless steel extending 12 inches on either side of barrier and secured to insulation with 3/8" wide band. Seal annular space between jacket and pipe sleeves with Thunderline High Temperature Link Seal.
- G. Pipe wall penetrations exposed to view shall have tight fitting escutcheons or flanges to cover all voids around openings.

- H. All below grade and exterior wall penetrations shall be installed in a pipe sleeve and sealed between the pipe and pipe sleeve with Thunderline High Temperature Link Seal or similar compressed link type system.
- I. Provide sleeves through all fire-rated walls and fill voids surrounding sleeves and interior to sleeves around cables with Nelson "Flameseal" fire stop putty with U.L. listed 3 hour rating installed as per manufacturers recommendations.
- J. Equivalent by Dow, Chemelex, 3M.

**3.3. PIPE HANGERS AND SUPPORTS**

- A. Provide and be responsible for locations of piping hangers, supports and inserts, etc., required for installation of piping under this contract. Design of hangers and supports shall conform to current issue of Manufacturers Standardization Society Specification (MSS) SP-58.
- B. Pipe hangers shall be capable of supporting piping in all conditions of operation. They shall allow free expansion and contraction of piping, and prevent excessive stress resulting from transferred weight being induced into pipe or connected equipment. Support horizontal or vertical pipes at locations of least vertical movement.
- C. Where horizontal piping movements are such that hanger rod angularity from vertical is greater than 4 degrees from cold to hot position of pipe, offset hanger, pipe, and structural attachments to that rod is vertical in hot position.
- D. Hangers shall not become disengaged by movements of supported pipe.
- E. Provide sufficient hangers to adequately support piping system at specified spacing, at changes in piping direction and at concentrated loads. Hangers shall provide for vertical adjustment to maintain pitch required for proper drainage, and for longitudinal travel due to expansion and contraction of piping. Fasten hangers to building structural members wherever practicable.
- F. Unless indicated otherwise on drawings support horizontal steel piping as follows:

PIPE SIZE	ROD DIAMETER	MAXIMUM SPACING
Up to 1-1/4"	3/8"	8 Ft.
1-1/2" to 2"	3/8"	10 Ft.
2-1/2" to 3-1/2"	1/2"	12 Ft.
4" and 5"	5/8"	15 Ft.

- G. Unless indicated otherwise on drawings support horizontal copper tubing as follows:

NOM. TUBING SIZE	ROD DIAMETER	MAXIMUM SPACING
Up to 1"	3/8"	6 Ft.
1-1/4" to 1-1/2"	3/8"	8 Ft.
2"	3/8"	9 Ft.
2-1/2"	1/2"	9 Ft.
3" and 4"	1/2"	10 Ft.

- H. Support horizontal cast iron soil pipe with two hangers for each section located close to each hub.
- I. Support vertical cast iron soil pipe at every floor, steel and copper tubing at every other floor except where indicated otherwise on drawings.
- J. Provide continuous threaded hanger rods wherever possible. No chain, wire, or perforated straps shall be used.
- K. Hanger rods shall be subject to tensile loading only, where lateral or axial pipe movement occurs provide suitable linkage to permit swing. Provide pipe support channels with galvanized finish for concealed locations and painted finish for exposed locations. Submit design for multiple pipe supports indicating pipe sizes, service and support detail to Architect-Engineer for review prior to fabrication.
- L. Provide Grinnell pipe hangers for vertical pipe risers as follows:

PIPE MATERIAL	PIPE SIZE	HANGER FIG. NO.
Copper	1/2" thru 4"	CT-121
Steel	3/4" thru 20"	261

- M. Provide Grinnell Fig. 194, 195 or 199 steel wall brackets for piping suspended or supported from walls. Brackets shall be prime coated carbon steel.

- N. Mount hangers for insulated piping on outside of pipe insulation sized to allow for full thickness of pipe insulation.
- O. Provide Grinnell Fig. 167 insulation protection shields sized so that line compressive load does not exceed one-third of insulation compressive strength. Shield shall be galvanized steel and support lower 180 degrees of pipe insulation on copper tubing. Provide wood block at each pipe hanger in thickness of insulation. Insulation vapor barrier jacket shall overlap wood block to maintain vapor barrier.
- P. Structural attachments for pipe hangers shall be as follows:
- Q. Concrete Structure: Provide Grinnell Fig. No. 285 cast in concrete insert for loads up to 400 lbs. and Grinnell Fig. 281 wedge cast in type concrete insert for loads up to 1200 lbs.
- R. Provide Grinnell pipe hangers for horizontal single pipe runs as follows:

PIPE MATERIALS	PIPE SIZE	HANGER FIG. NO.
Copper	½" thru 4"	CT-65
Steel	3/8" thru 4"	65
Steel	5" thru 30"	260

- S. Provide Fee and Mason Fig. 600 channel trapeze pipe hangers for horizontal multiple pipe runs with pipe clamps or pipe rollers as follows:

PIPE MATERIALS	PIPE SIZE	CLAMP NO.	ROLLER NO.
Copper	3/8" thru 4"	8600 CP*	8010 CP*
Steel	3/8" thru 6"	8500	8010

\*Copper Plated

- T. Pipe supports for horizontal piping mounted on pipe racks or stanchions shall be Advanced Thermal Systems low friction graphite slide supports or equivalent by Elcen or Grinnell. Where racks and supports are not detailed on drawings submit detailed support drawings to Architect-Engineer for review prior to fabrication.
- U. Provide Fee and Mason Fig. 404 vibration control hangers at locations where piping vibrations would be transmitted to building structure by conventional hangers. Apply hangers within their load supporting range.
- V. Provide Elcen Fig. 50 pipe saddle with adjuster to support piping from floor. Provide complete with pedestal type floor stand.
- W. Provide necessary structural steel and attachment accessories for installations of pipe hangers and supports. Where heavy piping loads are to be attached to building structure verify structural loading with Architect-Engineer prior to installations.
- X. Equivalent hangers and supports by Auto-Grip, Basic Engineer, Bee Line, Elcen, Fee & Mason, Fluorocarbon Company, Unistrut or Super Strut Inc.
- A. Provide premanufactured pipe support for piping located on flat roofs, unless otherwise indicated on drawings. Support will be of modular designs with roller bearings and guide saddles for straight piping runs longer than 50' and Unistrut type clamp/support type for other shorter runs. Maximum pipe support spacing shall be 10' for steel piping. Copper piping and refrigerant piping shall be supported at shorter distances. Piping near equipment connections shall be supported within 3' of units. System supports shall be compatible with roofing materials and shall be provided with plates, pads, etc to spread weight and wear on roof surface. Provide pipe supports from Miro Industries, B-Line, or approved equivalent.

**END OF SECTION 232000**

## SECTION 233113 – METAL DUCTS

### PART 1 GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 230010.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. SUMMARY

- A. Section Includes:
  - 1. Single-wall rectangular ducts and fittings.
  - 2. Double-wall rectangular ducts and fittings.
  - 3. Single-wall round and flat-oval ducts and fittings.
  - 4. Double-wall round and flat-oval ducts and fittings.
  - 5. Sheet metal materials.
  - 6. Sealants and gaskets.
  - 7. Hangers and supports.

#### 1.3. PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

#### 1.4. SUBMITTALS

- A. Product Data: For each type of the following products:
  - 1. Liners and adhesives.
  - 2. Sealants and gaskets.
- B. Shop Drawings:
  - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - 2. Factory- and shop-fabricated ducts and fittings.
  - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
  - 4. Elevation of top of ducts.
  - 5. Dimensions of main duct runs from building grid lines.
  - 6. Fittings.
  - 7. Reinforcement and spacing.
  - 8. Seam and joint construction.
  - 9. Penetrations through fire-rated and other partitions.
  - 10. Equipment installation based on equipment being used on Project.
  - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
  - 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- C. Delegated-Design Submittal:
  - 1. Sheet metal thicknesses.
  - 2. Joint and seam construction and sealing.
  - 3. Reinforcement details and spacing.
  - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
- D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
  - 2. Suspended ceiling components.
  - 3. Structural members to which duct will be attached.

4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Perimeter moldings.

- E. Welding certificates.
- F. Field quality-control reports.

## PART 2 PRODUCTS

### 2.1. SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct allowing for insulation if lined.

### 2.2. DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. McGill AirFlow LLC.
  2. Sheet Metal Connectors, Inc.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. Interstitial Insulation: Flexible duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
- E. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch diameter perforations, with overall open area of 23 percent.

### 2.3. SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Lindab Inc.
  - b. McGill AirFlow LLC.
  - c. SEMCO Incorporated.
  - d. Sheet Metal Connectors, Inc.
  - e. Spiral Manufacturing Co., Inc.
  - f. Norlock Metal Products, Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
  2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.



- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- F. All exposed round ducts shall be spiral wound construction.
- G. Concealed low pressure round ducts may be snap-lock construction when 8" or less. 10" round ducts shall be spiral wall construction.

#### 2.4. DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Lindab Inc.
  - 2. McGill AirFlow LLC.
  - 3. SEMCO Incorporated.
  - 4. Sheet Metal Connectors, Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
  - 1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
  - 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
    - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
  - 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    - D. Inner Duct: Minimum 0.028-inch [perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent] [solid sheet steel].
    - E. Interstitial Insulation: Flexible duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

#### 2.5. ELBOW CONFIGURATION:

- A. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - 1. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - 2. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - 3. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- B. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
  - 1. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - a. Radius-to Diameter Ratio: 1.5.
  - 2. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
  - 3. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.

## 2.6. BRANCH CONFIGURATION:

- A. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
  - 1. Rectangular Main to Rectangular Branch: 45-degree entry.
  - 2. Rectangular Main to Round Branch: High Efficiency 45 degree takeoff.
- B. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
  - 1. Velocity 1000 fpm or Lower: 90-degree tap.
  - 2. Velocity 1000 to 1500 fpm: Conical tap.
  - 3. Velocity 1500 fpm or Higher: 45-degree lateral.

## 2.7. SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface.
  - 3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- F. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

## 2.8. SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
  - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  - 2. Sealant: Modified styrene acrylic.
  - 3. Indoor and outdoor, Water resistant, Mold and mildew resistant.
  - 4. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
- C. Water-Based Joint and Seam Sealant:
  - 1. Application Method: Brush on.
  - 2. Solids Content: Minimum 65 percent.
  - 3. Shore A Hardness: Minimum 20.
  - 4. Indoor or outdoor, Water resistant, Mold and mildew resistant.
  - 5. VOC: Maximum 75 g/L (less water).
  - 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
- D. Solvent-Based Joint and Seam Sealant:
  - 1. Application Method: Brush on.
  - 2. Base: Synthetic rubber resin.
  - 3. Solids Content: Minimum 60 percent.
  - 4. Indoor or outdoor, Water resistant, Mold and mildew resistant.

5. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
  - E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
  - F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
  - G. Round Duct Joint O-Ring Seals:
    1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
    2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
    3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.
  - H. Pressure sensitive duct joint sealer:
    1. Provide Hard Cast, Inc. "Foil Grip" pressure sensitive duct joint sealer. Seal class "A", "B", and "C".

## 2.9. HANGERS AND SUPPORTS

- A. Indicate the extent of corrosive environment on Drawings.
- B. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- C. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- D. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- E. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- F. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- G. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- H. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- I. Trapeze and Riser Supports:
  1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## PART 3 EXECUTION

### 3.1. DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. All metal ductwork scheduled for interior thermal and acoustical liner is not sized on plans to include the proper thickness of insulation. Add 1" or 2" in height and width of ductwork as required to accommodate insulation thickness. Mount specialties such as turning vanes, dampers, etc., to ductwork with that section insulated "Build Outs" to maintain continuity of thermal barrier.
- D. All ductwork within 15 feet of connection to rooftop units shall be constructed to 6" WG class regardless of unit static pressure ratings and be a minimum of 18 gauge sheet metal. Roof deck shall only be cut out as required for ductwork penetrations and annular gap around duct shall be sealed with elastomeric caulk to reduce rooftop unit breakout noise.
- E. Install round and flat-oval ducts in maximum practical lengths.
- F. Install ducts with fewest possible joints.
- G. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- H. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- J. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- K. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- L. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

- M. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- N. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

### 3.2. INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3. ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 12 feet horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

### 3.4. DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the scheduled seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
- C. In residential occupancies duct tightness shall be verified by either of the following:
  1. Postconstruction test: Total leakage shall be less than or equal to 4 cfm (113.3 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. All register boots shall be taped or otherwise sealed during the test.
  2. Rough-in test: Total leakage shall be less than or equal to 4 cfm (113.3 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure. All registers shall be taped or otherwise sealed during the test. If the air handler is not installed at the time of the test, total leakage shall be less than or equal to 3 cfm (85 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area.
  3. Exception: The total leakage test is not required for ducts and air handlers located entirely within the building thermal envelope.

### 3.5. HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  1. Where practical, install concrete inserts before placing concrete.
  2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal

- screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6. CONNECTIONS

- A. Coordinate duct installations and specialty arrangements with Drawings.
- B. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- C. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7. PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.8. FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  2. Test the following systems:
    - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
  3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  4. Test for leaks before applying external insulation.
  5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
  6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
  1. Visually inspect duct system to ensure that no visible contaminants are present.
  2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
  3. Duct system will be considered defective if it does not pass tests and inspections.
  4. Prepare test and inspection reports.

3.9. START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10. DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

SYSTEM	Material	Pressure Class	Min. SMACNA Seal Class	Leakage Class
Supply				
Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units	Galv. SM	2" Pos.	C	Round-3 Rect-6
Ducts Connected to Variable-Air-Volume Air-Handling Units	Galv. SM	4" Pos.	B	Round-3 Rect-6

Ducts Connected to Constant-Volume Air-Handling Units	Galv. SM	2" Pos.	B	Round-3 Rect-6
Return				
Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units	Galv. SM	2" Neg.	C	Round-3 Rect-6
Ducts Connected to Air-Handling Units	Galv. SM	2" Neg.	C	Round-3 Rect-6
Ducts Connected to Rooftop Air Conditioner Units	Galv. SM	2" Neg.	C	Round-3 Rect-6
Exhaust				
Ducts Connected to General Exhaust	Galv. SM	2" Pos. or Neg.	B	Round-3 Rect-6
Exposed Ducts Connected to Commercial Kitchen Hoods	304 SS sheet, No. 4 finish (welded)	3" Neg.	A	3
Concealed Ducts Connected to Commercial Kitchen Hoods	Carbon-steel (welded)	3" Neg.	A	3
Ducts Connected to Dishwasher Hoods:	304 SS sheet, No. 4 finish (welded)	2" Neg.	A	3
Ducts Connected to Dishwasher Hoods:	304 SS sheet, (welded)	2" Neg.	A	3
Outside Air				
Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units	Galv. SM	2" Neg.	C	Round-3 Rect-6
Ducts Connected to Air-Handling Units	Galv. SM	2" Neg.	C	Round-3 Rect-6
Outdoor Ducts				
Ducts Connected to Air-Handling Units and Fans	Galv. SM	3" Pos.	A	Round-3 Rect-6

### 3.11. CLOTHES DRYER EXHAUST SYSTEM DUCTWORK

- A. Dryer exhaust ducts shall be constructed of minimum 0.016-inch thick (0.4 mm) ridged metal ducts, having smooth interior surfaces with joints running in the direction of flow. Exhaust Ducts shall not be connected or installed with sheet metal screws or other fasteners that will obstruct the flow. Ductwork shall be riveted for a smooth interior connector. Tape shall not be used as the only means to secure the connections.
- B. Exhaust ducts shall terminate on the outside of the building. Exhaust duct terminations shall be made in accordance with the dryer manufacturer's installation instructions. Exhaust ducts shall terminate at a location as required by the manufacturer's instructions. If the manufacturer's instructions do not specify a termination location, the exhaust duct shall terminate not less than 3 feet (914 mm) in any direction from openings into buildings. Exhaust duct terminations shall be equipped with a backdraft damper. Screens shall not be installed at the duct termination.
- C. The maximum length of a clothes dryer exhaust duct shall not exceed 25 feet from the dryer location to the wall or roof termination. The maximum length of the duct shall be reduced 2.5 feet for each 45-degree bend and 5 feet for each 90-degree bend. The maximum length of the exhaust duct does not include the transition duct.
- D. After riveting duct joints shall be sealed using Hard Cast, Inc. "Foil Grip" pressure sensitive duct joint sealer.
- E. For residential style exhaust systems exceeding 25 feet in equivalent length and less than 60 feet and 6 elbows provide Fantech Model FR110 capable of 100cfm at 0.7" ESP, 120 volt. Provide with automatic pressure switch to turn fan on and off when dryer is running.

### 3.12. DUST COLLECTION SYSTEM DUCTWORK

- A. Provide new commercial quality, smooth round welded ductwork and fittings. 18 gauge galvanized ductwork and transitions up to 8" diameter, 16 gauge galvanized ductwork and transitions from 9" diameter up to 18"

diameter, 14 gauge galvanized ductwork and transitions from 19" diameter up to 30" diameter, and 12 gauge for all ductwork above 30" diameter.

- B. Elbows shall be two gauges heavier than the same size ductwork. Elbows shall be constructed to be two times centerline radius.
- C. All connections shall be flanged and bolted connections.

**END OF SECTION 233113**

## SECTION 233300 – AIR DUCT ACCESSORIES

### PART 1 GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 230010.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

- a. Special fittings.
- b. Manual volume damper installations.
- c. Control damper installations.
- d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
- e. Wiring Diagrams: For power, signal, and control wiring.

2. Operation and maintenance data.

#### C. QUALITY ASSURANCE

1. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
2. Comply with AMCA 500-D testing for damper rating.

### PART 2 PRODUCTS

#### 2.1. MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.

2. Exposed-Surface Finish: Mill phosphatized.

- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

#### 2.2. BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.
2. Cesco Products.
3. Duro Dyne Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. NCA Manufacturing, Inc.
7. Pottorff; a division of PCI Industries, Inc.
8. Ruskin Company.
9. SEMCO Incorporated.
10. Vent Products Company, Inc.

- B. Description: Gravity balanced.

C. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

D. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum with sealed edges.

E. Blade Action: Parallel.



- F. Blade Seals: Neoprene, mechanically locked.
- G. Blade Axles: Nonferrous metal.
- H. Tie Bars and Brackets: Galvanized steel.
- I. Return Spring: Adjustable tension.
- J. Bearings: Steel ball or synthetic pivot bushings.
- K. Accessories:

- 1. Adjustment device to permit setting for varying differential static pressure.
- 2. Counterweights and spring-assist kits for vertical airflow installations.
- 3. Electric actuators.
- 4. Chain pulls.
- 5. Retain one of first two subparagraphs below.
- 6. Screen Mounting: Front mounted in sleeve.

- a. Sleeve Thickness: 20-gage minimum.
- b. Sleeve Length: 6 inches minimum.

- L. Screen: Rear mounted. Galvanized steel. Bird.
- M. 90-degree stops.

### 2.3. MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Air Balance Inc.
  - b. Flexmaster U.S.A., Inc.
  - c. McGill AirFlow LLC.
  - d. METALAIRE, Inc.
  - e. Nailor Industries Inc.
  - f. Pottorff; a division of PCI Industries, Inc.
  - g. Ruskin Company.
  - h. Trox USA Inc.
  - i. Vent Products Company, Inc.

- 2. Suitable for horizontal or vertical applications.
- 3. Frames: Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness. Mitered and welded corners. Flanges for attaching to walls and flangeless frames for installing in ducts.
- 4. Blades: Multiple or single blade. Parallel blade design for mixing applications and opposed-blade design for balance only applications. Stiffen damper blades for stability. Galvanized-steel, 0.064 inch thick.
- 5. Blade Axles: Galvanized steel.
- 6. Bearings: Molded synthetic. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 7. Tie Bars and Brackets: Galvanized steel.

- B. Jackshaft:

- 1. Size: 1-inch diameter.
- 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
- 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

- C. Damper Hardware:

- 1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
- 2. Include center hole to suit damper operating-rod size.
- 3. Include elevated platform for insulated duct mounting.

### 2.4. CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Cesco Products.
- 2. Duro Dyne Inc.
- 3. Flexmaster U.S.A., Inc.
- 4. Greenheck Fan Corporation.
- 5. McGill AirFlow LLC.

6. METALAIRE, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Young Regulator Company.

- B. Frames: Hat shaped. Galvanized-steel channels, 0.064 inch thick. Mitered and welded corners.
- C. Blades: Multiple blade with maximum blade width of 8 inches. Parallel-blade design when used at junctions of differing air temperatures and opposed-blade design otherwise. Galvanized steel. 0.064 inch thick. Closed-cell neoprene edging for low leakage applications.
- D. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
- E. Bearings: Molded synthetic. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft. Thrust bearings at each end of every blade.

## 2.5. FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Air Balance Inc.; a division of Mestek, Inc.
  2. Cesco Products; a division of Mestek, Inc.
  3. Greenheck Fan Corporation.
  4. McGill AirFlow LLC.
  5. METALAIRE, Inc.
  6. Nailor Industries Inc.
  7. NCA Manufacturing, Inc.
  8. Pottorff; a division of PCI Industries, Inc.
  9. Prefco; Perfect Air Control, Inc.
  10. Ruskin Company.
  11. Vent Products Company, Inc.
- B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: 1-1/2 and 3 hours.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
- G. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
- H. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- I. Mounting Orientation: Vertical or horizontal as indicated.
- J. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- K. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- L. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

## 2.6. SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Air Balance Inc.; a division of Mestek, Inc.
  2. Cesco Products; a division of Mestek, Inc.
  3. Greenheck Fan Corporation.
  4. Nailor Industries Inc.
  5. Prefco.
  6. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- D. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- E. Leakage: Class I.
- F. Rated pressure and velocity to exceed design airflow conditions.

- G. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.
- H. Damper Motors: two-position action.

1. Electrical Connection: 115 V, single phase, 60 Hz. Coordinate voltage with Fire alarm contractor prior to ordering. Where building is not equipped with a fire alarm system, provide a stand alone 120v smoke detector and remote LED indicator light mounted in ceiling below duct detector. Mount detector within 5' of damper and provide all necessary wiring and interconnections to damper and detector and relays/power supplies.

## 2.7. FIRE/SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Air Balance Inc.; a division of Mestek, Inc.
  - 2. Cesco Products; a division of Mestek, Inc.
  - 3. Greenheck Fan Corporation.
  - 4. Nailor Industries Inc.
  - 5. Prefco.
  - 6. Ruskin Company.
- B. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
  - C. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
  - D. Leakage: Class I.
  - E. Rated pressure and velocity to exceed design airflow conditions.
  - F. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.
  - G. Damper Motors: two-position action.
1. Electrical Connection: 115 V, single phase, 60 Hz. Coordinate voltage with Fire alarm contractor prior to ordering. Where building is not equipped with a fire alarm system, provide a stand alone 120v smoke detector and remote LED indicator light mounted in ceiling below duct detector. Mount detector within 5' of damper and provide all necessary wiring and interconnections to damper and detector and relays/power supplies.
2. Power open, locked and reset, spring closed.

## 2.8. TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. METALAIRE, Inc.
  - 4. SEMCO Incorporated.
  - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vaness and Vane Runners," and 2-4, "Vane Support in Elbows."
  - C. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

## 2.9. DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Cesco Products; a division of Mestek, Inc.
  - 2. Ductmate Industries, Inc.
  - 3. Flexmaster U.S.A., Inc.
  - 4. Greenheck Fan Corporation.
  - 5. McGill AirFlow LLC.
  - 6. Nailor Industries Inc.
  - 7. Pottorff; a division of PCI Industries, Inc.
  - 8. Ventfabrics, Inc.
  - 9. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:

- a. Double wall, rectangular. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. 1-by-1-inch butt or piano hinge and cam latches.
  - b. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
- a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
  - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
  - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
  - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

#### 2.10. FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. Ventfabrics, Inc.
  - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
1. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene. 26 oz./sq. yd. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

#### 2.11. LOW PRESSURE FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Flexmaster U.S.A., Inc.
  - 2. McGill AirFlow LLC.
  - 3. Thermaflex
  - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Low Pressure Flexible Duct
1. Thermaflex M-KE rated for +6" W.G. max. and -1" W.G. max. for duct sizes 4" to 14", +6" W.G. max. and -0.5" W.G. max for duct sizes 14" to 16", +4" W.G. max. and -0.5" W.G. max for duct sizes 18" to 20". Rated for 3500 FPM maximum velocity. UL listed "UL-181 Standards Class I Duct Material" complying with NFPA Standards 90A and 90B. Duct shall be composed of an acoustically rated inner polymeric liner duct bonded to coated steel wire helix. Fiberglass insulation and tear resistant metalized polyester film outer vapor barrier. Maximum flexible duct length or run shall be 5'-0" unless otherwise noted. Flexible ductwork shall be securely attached to both the rigid duct connection and diffuser neck with plastic band clamps or stainless steel worm driven clamps. Equivalent by Wiremold, Cleavaflex, Flexmaster.

#### 2.12. HIGH PRESSURE FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Flexmaster U.S.A., Inc.
  - 2. McGill AirFlow LLC.
  - 3. Thermaflex
  - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Flexible Duct Inlet to Terminal Boxes
1. Flexmaster type Triple Lock-Acoustic (TL/A) insulated acoustic air duct, manufactured by using a dead soft aluminum strip which is perforated, spirally wound and mechanically joined together. The inner duct is draped with a thick fiberglass insulation and covered by a flame retardant, non-toxic polyethylene vapor barrier. UL-181 Class 1 product uses a Triple Lock (T/L basic) perforated core with an open area of 20% to 25% to completely cushion sounds such as air movement and duct vibrations.
2. Maximum flexible duct length or run shall be 4'-0" unless otherwise noted. Attach ducts with metal screws and stainless steel clamp. Equivalent by Wiremold, Cleavaflex, Flexmaster.

## 2.13. DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 EXECUTION

### 3.1. INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
  - B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
  - C. Install backdraft and control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
  - D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
1. Install steel volume dampers in steel ducts.
  2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
  - F. Install test holes at fan inlets and outlets and elsewhere as indicated.
  - G. Install fire and smoke dampers according to UL listing.
  - H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
    1. On both sides of duct coils.
    2. Upstream and downstream from duct filters.
    3. At outdoor-air intakes and mixed-air plenums.
    4. At drain pans and seals.
    5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
    6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
    7. Control devices requiring inspection.
    8. Elsewhere as indicated.
  - I. Install access doors with swing against duct static pressure.
  - J. Access Door Sizes:
    1. One-Hand or Inspection Access: 8 by 5 inches.
    2. Two-Hand Access: 12 by 6 inches.
    3. Head and Hand Access: 18 by 10 inches.
    4. Head and Shoulders Access: 21 by 14 inches.
    5. Body Access: 25 by 14 inches.
    6. Body plus Ladder Access: 25 by 17 inches.
  - K. Install flexible connectors to connect ducts to equipment.
  - L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
  - M. Retain first paragraph below to allow use of flexible duct to connect terminal units to metal duct.
  - N. Connect terminal units to supply ducts directly with maximum 12-inch lengths of high pressure flexible duct. Do not use flexible ducts to change directions.
  - O. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
  - P. Connect flexible ducts to metal ducts with draw bands.
  - Q. Install duct test holes where required for testing and balancing purposes.

### 3.2. FIELD QUALITY CONTROL

- A. Tests and Inspections:
  1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

**END OF SECTION 233300**

## SECTION 233616 – VARIABLE AIR VOLUME BOXES

### PART 1 - GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 230010.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and scheduled.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

### PART 2 PRODUCTS

#### 2.1. GENERAL

- A. Furnish and install where shown on plans shut-off terminal units. All variable volume boxes shall be by one manufacturer.
- B. Equivalents by Titus, Carnes, EnviroTec, E.H. Price.

#### 2.2. UNIT

##### A. BOX

1. Provide units with capacities as scheduled. Provide where indicated on plans or schedules hydronic or electric reheat coils with capacities and characteristics as scheduled.
2. Casing shall be 22 gauge galvanized steel.
3. Interior surface of unit casing is acoustically and thermally lined with fiber free insulation. Insulation is UL listed and meets NFPA-90A and UL 181.
4. The VAV box shall be a flow control device with an integral electric actuator with electronic pressure independent controls. Box inlet is die cast aluminum and tapered to fit standard round flexible ductwork. Maximum leak rate is 1 percent at 4 inches WG. inlet static pressure,. Integral multiple point, averaging flow sensing ring to provide primary air flow measurement with □ 5 percent of unit rated airflow with 1-1/2 diameters of straight duct upstream of unit. Integral flow taps and calibration chart provided on each unit.
5. All units shall be UL listed and CSA approved.

##### B. HOT WATER COIL

1. Hot water coil shall be slip and drive connected as an integral part of the terminal nit. If insulation is scheduled it shall be field supplied and furnished. One and two row coils shall be constructed using ½" o.d. copper tubes, with rippled corrugated aluminum fins. Fin spacing shall be as scheduled or as required to meet capacity. Coil connections shall be either right or left hand. All hot water coils to be pre-tested under water at 350 psi.

##### C. ELECTRIC RESISTANCE COIL

1. Electric Resistance Heaters shall come factory mounted on the discharge of the terminal unit with the KW, voltage and steps as shown on the schedule. Heater casing shall be internally insulated requiring no field applied external insulation. Heater shall be inlet mounted to insure uniform velocity profile over heating elements, effectively eliminating nuisance tripping of safety limits and insuring positive air flow switch operation. The heater cabinet shall have a hinged access panel for entry to the heater controls mounted within the cabinet. Interlocking door power disconnect shall be furnished to render the heater non-operational during maintenance periods. Heater shall be furnished with all controls necessary for safe operation and for full compliance with UL and NEC requirements. Heater shall have a single point power connection and shall include primary disc-type automatic reset high temperature limit control, secondary high-limit control, air flow switch, 80/20 nickel chromium elements, fusing per UL and NEC, wiring diagram, and UL label.

- D. Automatic Temperature Control Interface: Equipment manufacturer (Rooftop Unit, Blower Coils VAV Terminals) shall take possession of and shall mount, wire, and factory test all required automatic temperature control devices as called out on plans and in "Automatic Temperature Control" Section of the Specifications. Only those manufacturers listed in the "Automatic Temperature Control" section of the specification will be acceptable to provide the controls as listed herein. If unit manufacturer does not have a means to take possession of, mount, wire and factory test controls as herein specified. Equipment manufacturer shall include in base bid price, cost for field mounting, wiring, and testing of above referenced controls by the Automatic Temperature Control

Contractor. Exceptions taken to this requirement will result in disapproval of equipment during the submittal phase of the project.

## SECTION 233750 – HVAC LOUVERS

### PART 1 GENERAL

#### 1.1. RELATED DOCUMENTS

- A. Reference Section 230010.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2. PERFORMANCE REQUIREMENTS

- A. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

#### 1.3. SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
- C. Product Test Reports: Based on tests performed according to AMCA 500-L.

### PART 2 PRODUCT

#### 2.1. LOUVERS

- A. Equivalent by Ruskin, Louvers and Dampers, Greenheck, American Warming and Ventilating, Industrial Louvers, ACME.
- B. Louvers shall be Ruskin Model ELF375DXH extruded 6063T5 aluminum alloy construction as follows: 4" deep frame, 0.125" wall thickness. 0.125" wall thickness blades, Drainable blades are positioned at 37-1/2° angle and spaced approximately 53/32" center to center. Screen: 3/4" x .051" expanded, flattened aluminum in removable frame. Provide in custom Kynar finish as selected by Architect. AMCA Certified.
- C. Louvers shall be stationary drainable type with drain gutters in each blade and downspouts in jambs and mullions. Louvers shall have a minimum of 54% free area based on a 48" wide x 48" high size. Stationary drainable blades shall be contained within a 4" frame. Louver components (heads, jambs, sills, blades, & mullions) shall be factory assembled by the louver manufacturer. Louver sizes too large for shipping shall be built up by the contractor from factory assembled louver sections to provide overall sizes required. Louver design shall limit span between visible mullions to 10 feet and shall incorporate structural supports required to withstand a windload of 20 lbs. per sq. ft. (equivalent of a 90 mph wind).
- D. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- E. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- F. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- G. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory and refinish entire unit or provide new units.
- H. Protect galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint.

**END OF SECTION 233750**



**BID FORM – EISENHOWER MIDDLE SCHOOL**

By signing this bid form, the vendor certifies the forms being offered meets or exceeds all requirements and conditions of the bid, special provisions and specifications. In compliance with the above and subject to all the conditions hereof, the undersigned offers and agrees to furnish all items upon which prices are quoted, at the price set opposite each item. The undersigned certifies that no Federal, State, County or Municipal tax is included in the above quoted prices and that none will be added. Public schools are EXEMPT. Project exemption certificates will be provided within five (5) days of award.

**BASE BID PRICE SHALL BE ALL INCLUSIVE INCLUDING MATERIAL, LABOR, & SUBCONTRACTOR’S COSTS.**

As a Bidder I will complete the Work for the following Items Bid:

<b>Components and Installation of Mechanical Systems &amp; Independent Air Balance and Testing Contractor Eisenhower Middle School</b>	
<b>Base Bid</b>	\$ _____

**Receipt of Addenda:**

The Bidder has examined copies of all bidding documents and of the Addenda, (receipt of all which is hereby acknowledged. Enter Addenda No. and Date of Addenda on the line below.

\_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

**List of Subcontractors**

<b>Description of Work</b>	<b>Subcontractor’s or Supplier’s Company Name</b>

**BID BOND:**

Each Bid must be accompanied by a Bid Bond payable to USD No. 500 for five percent (5%) of the Base Bid. The Bid Bond pledges that the Bidder will enter into a contract with USD No. 500 / Kansas City Kansas Public Schools on the terms stated in the bid.

**PERFORMANCE AND PAYMENT BOND:**

The successful Bidder shall provide a 100% percent of the contract Performance and Payment Bond or a Letter of Credit or any other security as approved by USD No. 500 / Kansas City Kansas Public Schools.

WE HEREBY AGREE TO FURNISH THE ITEMS ON WHICH PRICES ARE QUOTED ABOVE IN ACCORDANCE WITH ALL TERMS AND CONDITIONS PREVIOUSLY LISTED AND ANY ATTACHED SPECIFICATIONS.

BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
 TITLE: \_\_\_\_\_ FIRM: \_\_\_\_\_  
 PHONE: \_\_\_\_\_ EMAIL: \_\_\_\_\_

**BID FORM – FL SCHLAGLE HIGH SCHOOL**

By signing this bid form, the vendor certifies the forms being offered meets or exceeds all requirements and conditions of the bid, special provisions and specifications. In compliance with the above and subject to all the conditions hereof, the undersigned offers and agrees to furnish all items upon which prices are quoted, at the price set opposite each item. The undersigned certifies that no Federal, State, County or Municipal tax is included in the above quoted prices and that none will be added. Public schools are EXEMPT. Project exemption certificates will be provided within five (5) days of award.

**BASE BID PRICE SHALL BE ALL INCLUSIVE INCLUDING MATERIAL, LABOR, & SUBCONTRACTOR’S COSTS.**

As a Bidder I will complete the Work for the following Items Bid:

<b>Components and Installation of Mechanical Systems &amp; Independent Air Balance and Testing Contractor FL Schlagle High School</b>	
<b>Base Bid</b>	\$ _____

**Receipt of Addenda:**

The Bidder has examined copies of all bidding documents and of the Addenda, (receipt of all which is hereby acknowledged. Enter Addenda No. and Date of Addenda on the line below.

\_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_

**List of Subcontractors**

Description of Work	Subcontractor’s or Supplier’s Company Name

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**PERFORMANCE AND PAYMENT BOND:**

The successful Bidder shall provide a 100% percent of the contract Performance and Payment Bond or a Letter of Credit or any other security as approved by USD No. 500 / Kansas City Kansas Public Schools.

WE HEREBY AGREE TO FURNISH THE ITEMS ON WHICH PRICES ARE QUOTED ABOVE IN ACCORDANCE WITH ALL TERMS AND CONDITIONS PREVIOUSLY LISTED AND ANY ATTACHED SPECIFICATIONS.

BY: \_\_\_\_\_ DATE \_\_\_\_\_  
 TITLE: \_\_\_\_\_ FIRM: \_\_\_\_\_  
 PHONE: \_\_\_\_\_ EMAIL: \_\_\_\_\_

## ATTACHMENT A – USD 500 STANDARD TERMS AND CONDITIONS

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1. SCOPE: The following terms and conditions shall prevail unless otherwise modified by U.S.D. 500 within this bid document. U.S.D. 500 reserves the right to reject any bid which takes exception to these terms and conditions.
2. DEFINITIONS AS USED HEREIN:
  - a. The term "bid request" means a solicitation of a formal sealed bid.
  - b. The term "bid" means the price offered by the bidder.
  - c. The term "bidder" means the offeror or Contractor.
  - d. The term "U.S.D. 500" means Unified School District No. 500.
  - e. The term "Board of Education" or "BOE" means the governing body of Unified School District No.500
3. COMPLETING BID: Bids must be submitted ONLY on the form provided in this bid document. All information must be legible. Any and all corrections and /or erasures must be initialed. Each bid sheet must be signed by the authorized bidder and required information must be provided.
4. CONFIDENTIALITY OF BID INFORMATION: Each bid must be sealed and submitted in or under cover of the enclosed envelope to provide confidentiality of the bid information prior to the bid opening. Supporting documents and/or descriptive literature may be submitted with the bid or in a separate envelope marked "Literature for Bid (Number)." Do NOT indicate bid prices on literature. All bids and supporting bid documents become public information after the bid opening and are available for inspection by the general public in accordance with the Kansas Open Records Act.
5. ACCURACY OF BID: Each bid is publicly opened and is made part of the public record of U.S.D. 500. Therefore, it is necessary that any and all information presented is accurate and/or will be that by which the bidder will complete the contract. If there is a discrepancy between the unit price and extended total, the unit price will prevail.
6. SUBMISSION OF BID: Bids are to be sealed and submitted to the Purchasing Department Office, 2010 North 59<sup>th</sup> Street, Room 370, Kansas City, Kansas, 66104, prior to the date and time indicated on the cover sheet.
7. ADDENDA: All changes in connection with this bid will be issued by the Purchasing Office in the form of a written addendum. Signed acknowledgement of receipt of each addendum must be submitted with the bid.
8. LATE BIDS AND MODIFICATION OR WITHDRAWALS: Bids received after the deadline designated in this bid document shall not be considered and shall be returned unopened.
9. BIDS BINDING: All bids submitted shall be binding upon the bidder if accepted by U.S.D. 500 within sixty (60) calendar days after the bid opening.
10. EQUIVALENT BIDS: When brand or trade names are used in the bid invitation, it is for the purpose of item identification and to establish standards for quality, style and features. Bids on equivalent items of substantially the same quality, style and features are invited unless items are marked "No Substitute." Equivalent bids must be accompanied by descriptive literature and/ or samples may be required and shall be supplied at no charge to the school district.
11. NEW MATERIALS, SUPPLIES AND EQUIPMENT: Unless otherwise specified, all materials, supplies or equipment offered by a bidder shall be new, unused, of recent manufacture, first class in every respect, and suitable for their intended purpose. All equipment shall be assembled and fully serviced, ready for operation when delivered.
12. WARRANTY: Supplies or services furnished as a result of this bid shall be covered by the most favorable commercial warranties, expressed or implied, that the bidder and/or manufacturer gives to any customer. The rights and remedies provided herein are in addition to and do not limit any rights afforded to U.S.D. 500 by any other clause of this bid reserves the right to request from bidders a separate manufacturer certification of all statements made in the Proposal.
13. METHOD OF AWARD AND NOTIFICATION: Bids will be analyzed and the award made to the lowest and best, responsive and responsible bidder(s) whose bid conforms to the specifications and whose bid is considered to be the best value in the opinion of U.S.D. 500.
14. U.S.D. 500 reserves the right to reject any or all bids and any part of a bid: to waive informalities, technical defects, and minor irregularities in bids received: and to award the bid on an item by item basis by specified groups of items or to consider bids submitted on an "all or nothing "basis if the bid is clearly designed as such or when it is determined to be in the best interest of U.S.D. 500.
15. The signed bid shall be considered an offer on the part of the bidder: such offer shall be deemed accepted upon the issuance by U.S.D. 500 of a Purchase Order or other contractual document.
16. DELIVERY TERMS: All deliveries shall be F.O.B. Destination and all freight charges shall be included in the bid price.
17. DAMAGED AND/OR LATE SHIPMENTS: U.S.D 500 has no obligation to accept damaged shipments and reserves the right to return at the Contractor's expense damaged merchandise even though the damage was not apparent or discovered until after receipt of the items. The Contractor is responsible to notify U.S.D. 500 Purchasing Office of any late or delayed shipments. U.S.D. 500 reserves the right to cancel all or any part of an order if the shipment is not made as promised.
18. CREDIT TERMS: Bidder shall indicate all discounts for full and/or prompt payment. Discounts shall be considered as a cost factor in the determination of award, except discounts offered for payment within less than ten (10) calendar days. Discounts offered shall be computed from date of receipt of correct invoice or receipt and acceptance of products, whichever is later.
19. SELLER'S INVOICE: Invoices shall be prepared and submitted in duplicate to address shown on the Purchase Order. Invoices shall contain the following information: Purchase Order number, contract number, item number, description of supplies or services, sizes, unit of measure, quantity, unit price and extended totals.
20. TAX EXEMPT: U.S.D. 500 is exempt from Federal, State and local taxes by KS-FZLEKBLQ. Sites of all transactions under the order(s) that shall be derived from this bid request shall be deemed to have been accomplished within the State of Kansas.

- 21. SAFETY: All practices, materials, supplies and equipment shall comply with the federal Occupational Safety and Health Act, as well as any pertinent Federal, State and/or local safety or environmental codes.
- 22. DISCLAIMER OR LIABILITY: U.S.D. 500 will not hold harmless or indemnify any bidder for any liability whatsoever.
- 23. TERMINATION RIGHTS: KCKPS shall have the right to terminate/cancel the Agreement for its convenience and without penalty upon thirty (30) days prior written notice to the Contractor.
- 24. HOLD HARMLESS: The Contractor agrees to protect, defend, indemnify and hold the Board of Education, its officers, employees and agents fee and harmless from and against any and all losses, penalties, damages, settlements, costs, charges, professional fees or other expenses or liabilities of every kind and character arising out of or relating to any and all claims, liens, demands, obligations, actions, proceedings or causes of action of every kind and character in connection with or arising directly or indirectly out of this agreement and/or the performance hereof. Without limiting the generality of the foregoing, any and all such claims, etc., relating to personal injury, infringement of any patent trademark, copyright (or application for any thereof) or of any other tangible or intangible personal or property right, or actual or alleged violation of any applicable statute, ordinance, administrative order, rule or regulation, or decree of any court, shall be included in the indemnity hereunder. The Contractor further agrees to investigate, handle, respond to, provide defense for and defend any such claims, etc., at his/her sole expense and agrees to bear all other costs and expenses related thereto, even if such claim is groundless, false or fraudulent.

**NO MUTUAL INDEMNIFICATION:**

K.S.A.72-8201a: Contracts; indemnification or hold harmless provisions, void.

(a) It is the public policy of the state of Kansas that all contracts entered into by the board of education of a school district, or any officers or employees thereof acting on behalf of the board, provide that the school district and board of education shall be responsible solely for the district's or board's actions or failure to act under a contract.

(b) The board of education of a school district or any officers or employees thereof acting on behalf of the board shall not have the authority to enter into a contract under which the school district or board agrees to, or is required to, indemnify or hold harmless against damages, injury or death resulting from the actions or failure to act on the part of any party to a contract other than the board or district.

(c) The provisions of any contract entered into in violation of this section shall be contrary to the public policy of the state of Kansas and shall be void and unenforceable.

- 25. INSURANCE: Upon receipt of award, Contractor shall provide Certificate of Insurance as required within three (3) days after notification issued by the Purchasing Department.

A. The following general insurance requirements apply to any and all work under this contract by all Contractors and subcontractors of any tier.

- (1) Any and all insurance required by this contract with each and any and all insurance required by this contract shall be maintained during the entire length of this contract, including any extensions thereto, and until all work has been completed to the satisfaction of the Kansas City Kansas Public Schools. Any and all insurance must be on an occurrence basis.
- (2) No Contractor or subcontractor shall commence work under a contract until all insurance requirements contained within the solicitation have been complied with and until evidence of all insurance requirements in each and every contract with each and every subcontractor of any tier and shall require the same to comply with all such requirements.
- (3) The Kansas City Kansas Public Schools shall be covered as an Additional Insured under any and all insurance required by this contract. Confirmation of this shall appear on all certificates of insurance and on any and all applicable policies. The title of the awarded contract shall also appear on any and all applicable policies.
- (4) The Kansas City Kansas Public Schools shall be given no less than thirty (30) days' written notice of cancellation. The Kansas City Kansas Public Schools shall be given not less than thirty (30) days' prior written notice of material changes of any insurance required under this contract. The Kansas City Kansas Public Schools shall be given written notice of renewal of coverage not less than thirty (30) days prior to the expiration of any particular policy.
- (5) Each and every agent shall warrant when signing the certificate of insurance that he is acting as an authorized representative on behalf of the companies affording insurance coverage under the contract and that he is licensed by the State of Kansas to conduct insurance business in the State of Kansas and that the companies affording insurance coverage are currently licensed by the State of Kansas and are currently in good standing with the Commissioner of Insurance for the State of Kansas.
- (6) Any and all companies providing insurance required by this contract shall meet the minimum financial security requirements as set forth below. The rating for each company must be indicated on the certificate of insurance.

For all contracts, regardless of risk, companies providing insurance under this contract must have a current:

- (a) Best's Rating not less than A, and
- (b) Best's Financial Size Category not less than Class VII

- (7) In the event the Contractor neglects, refuses, or fails to provide insurance required by the contract documents, or if such insurance is canceled for any reason, Kansas City Kansas Public Schools shall have the right, but not the duty, to procure the same, and the cost thereof shall be deducted from monies then due or thereafter to become due to the Contractor or Kansas City Kansas Public Schools shall have the right to cancel the contract.

B. Worker's Compensation and Employer's Liability Insurance

The Contractor shall procure and maintain Worker's Compensation and Employer's Liability Insurance in the following limits. Such insurance is to cover each and every employee who is or may be engaged in work under this contract.

Worker's Compensation.....Statutory

Employer's Liability

Bodily Injury by Accident .....	\$1,000,000	each accident
Bodily Injury by Disease .....	\$1,000,000	each employee
Bodily Injury by Disease .....	\$1,000,000	policy limit

C. Comprehensive General Liability Insurance

The Contractor shall procure and maintain Comprehensive Insurance in an amount not less than \$1,000,000 for bodily injury and property damage combined single limit. The following specific extensions of coverage shall be provided and indicated on the certificate of insurance:

- (1) Comprehensive Form
- (2) Contractual Insurance
- (3) Personal Injury
- (4) Broad Form Property Damage
- (5) Premises – Operations
- (6) Completed Operations

This coverage shall cover the use of all equipment, hoists, and vehicles on the site(s) not covered by Automobile Liability under this contract. Policy coverage must be on an occurrence basis.

D. Automobile Liability Insurance

The Contractor shall procure and maintain Automobile Liability Insurance in an amount not less than \$1,000,000 for bodily injury and property damage combined single limit. The following extensions of coverage shall be provided and indicated on the certificate of insurance.

- (1) Comprehensive Form
- (2) Owned, Hired, Leased and non-owned vehicles

If the Contractor does not own any vehicles in the corporate name, non-owned vehicles coverage shall apply and must be endorsed on either the Contractor's personal automobile policy or the Comprehensive General Liability coverage required under this contract.

E. Commercial Crime insurance (when applicable)

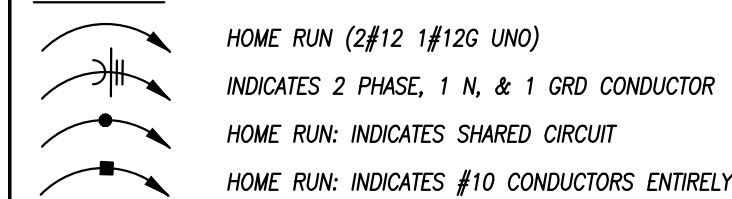
The Contractor shall procure and maintain Commercial Crime/Fidelity insurance in an amount not less than \$1,000,000.00, including coverage for theft or loss of KCKPS property.

- 26. LAW GOVERNING: All contractual agreements shall be subject to, governed by, and construed according to the laws of the State of Kansas.
- 27. ANTI-DISCRIMINATION CLAUSE: No bidder on this request shall in any way, directly or indirectly, discriminate against any person because of age, race, color handicap, sex, national origin, or religious creed.
- 28. BID BOND/PERFORMANCE BOND (Applicable to Construction/Remodel/Repair Projects, Unless Waived by the District)
  - A. Each proposal must be accompanied by a certified or cashier's check, or a bid bond in the amount of five percent (5%) of the Contractor's total bid.
  - B. A Performance Bond and a Material and Labor Payment Bond in amounts equal to one hundred percent (100%) of the contract price shall be furnished by the successful bidder. Bonds shall be issued by a surety acceptable to the Board.
- 29. DISQUALIFICATION:
  - A. The Director of Purchasing may, at her/his sole discretion, disqualify a bidder for one or any combination of the following reasons:
    - 1. Bidder's product does not meet the specifications or bid conditions of the solicitation;
    - 2. Bidder's tendered bid is not received on the District's bid form;
    - 3. Bidder's tendered bid is not signed;
    - 4. Required bid bond is not furnished at time of bid opening;
    - 5. Failure to comply with bid instructions, terms and conditions that are judged to be essential to the competitive process and in the best interests of the District.
  - B. Disqualification of bidders on future bids may be considered for any one or combination of the following reasons:
    - 1. Refusal of the bidder to complete a contract or bid;
    - 2. Bidder's past history of late deliveries or partial/incomplete shipments,
    - 3. Bidder's products or services have proven unreliable, unworkable or have not accomplished the result requested in the District's specifications.
- 30. SUPPLIER DIVERSITY: The Kansas City Kansas Public Schools encourages supplier diversity and participation of MBE/WBE/DBE designated businesses. However, such participation will not result in any selection or scoring advantage in the bid evaluation process.

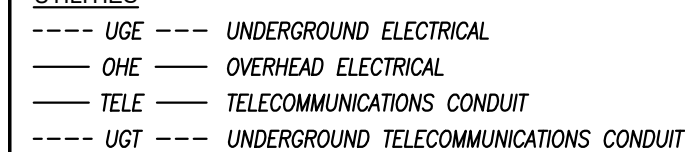
## ELECTRICAL SYMBOL LEGEND

SOME SYMBOLS AND ABBREVIATIONS ON THIS LEGEND MAY NOT BE USED

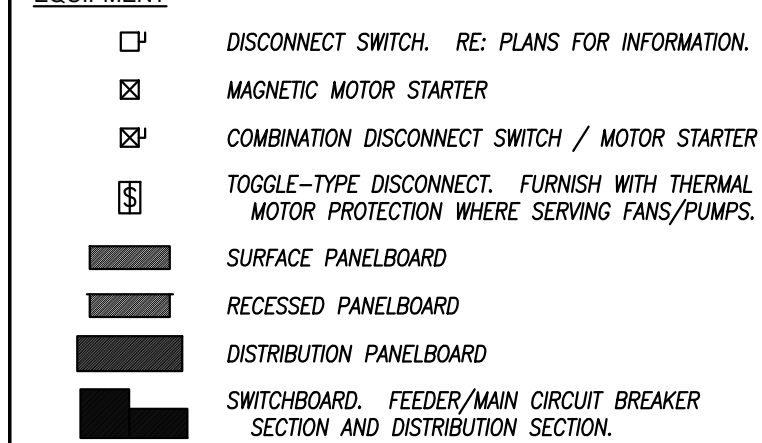
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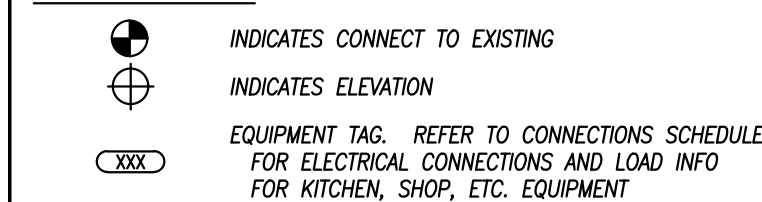
### UTILITIES



### EQUIPMENT



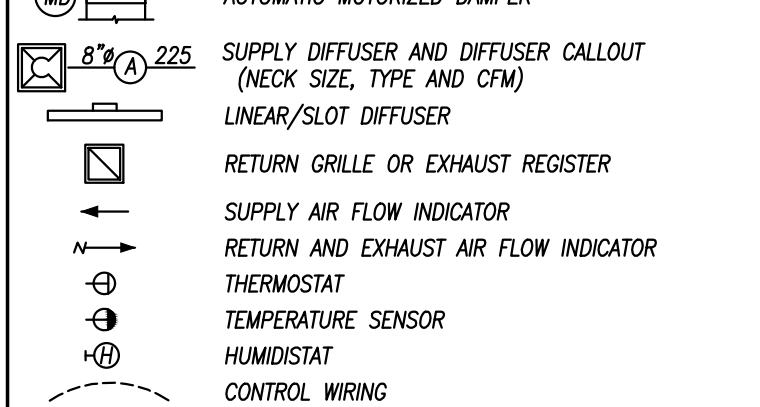
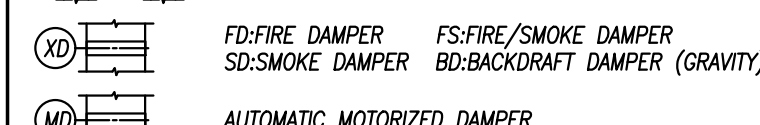
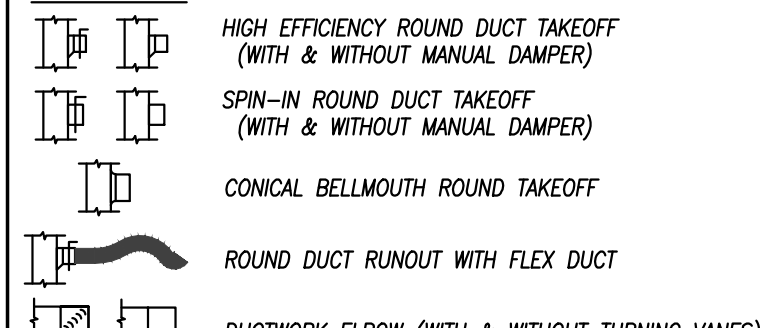
### GENERAL SYMBOLS



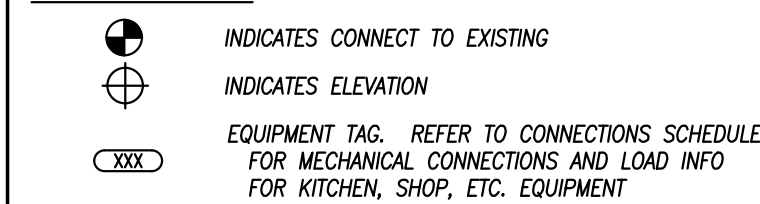
## MECHANICAL AND PLUMBING SYMBOL LEGEND

SOME SYMBOLS AND ABBREVIATIONS ON THIS LEGEND MAY NOT BE USED

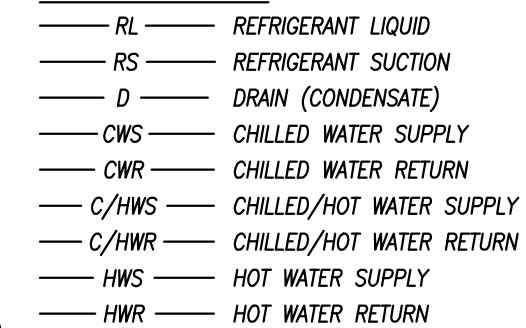
### SHEET METAL



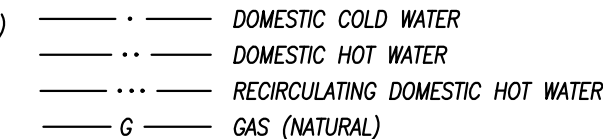
### GENERAL SYMBOLS



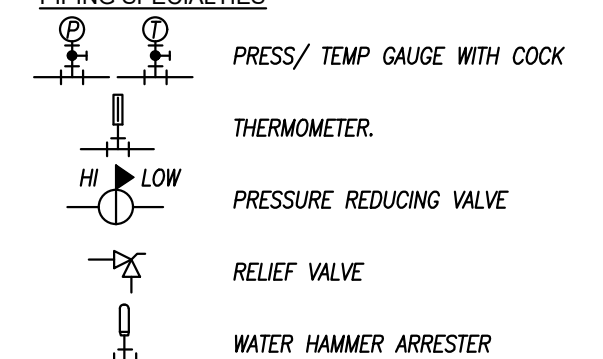
### MECHANICAL PIPING



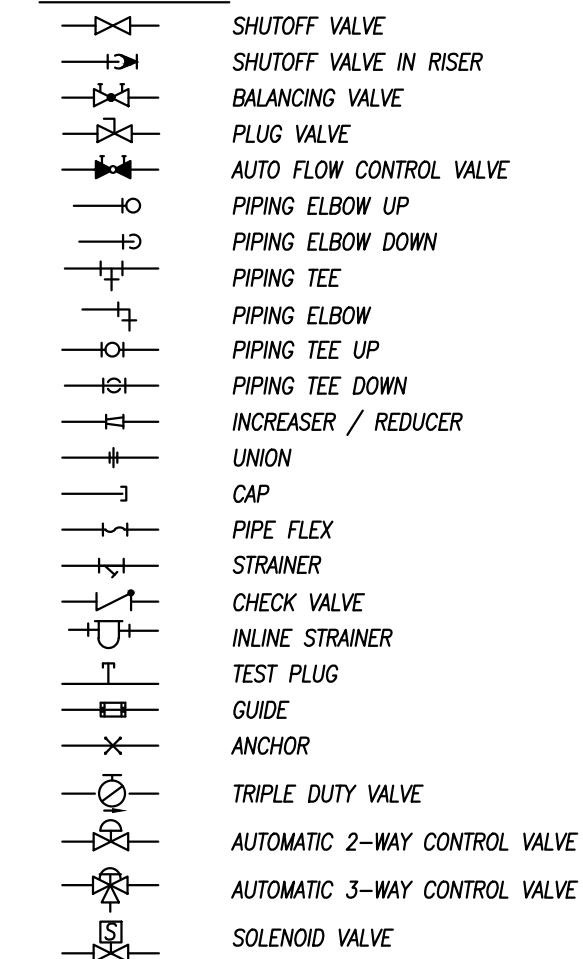
### PLUMBING PIPING



### PIPING SPECIALTIES



### PIPING SYMBOLS



## DEMOLITION NOTES

- ALL WORK SHOWN DARK AND DASHED IS TO BE DEMOLISHED. WORK SHOWN LIGHT IS EXISTING TO REMAIN.
- REFER TO ARCHITECTURAL PLANS FOR FURTHER EXTENT OF DEMOLITION REQUIREMENTS.
- ALL EXISTING PIPING SCHEDULED FOR DEMOLITION THAT ROUTES BELOW SLAB SHALL BE REMOVED WITH FLOOR, PLUGGED AND THE FLOOR PATCHED TO MATCH SURROUNDING FLOOR.
- COORDINATE ALL DEMOLITION WORK WITH OWNER.
- CONTACT UTILITY LOCATING SERVICE TO LOCATE EXACT LOCATION OF UTILITIES BELOW GRADE.
- MAINTAIN ALL EXISTING DEVICES, EQUIPMENT, ASSOCIATED CIRCUITS ETC. SHOWN AS EXISTING TO REMAIN OR OTHERWISE UNRELATED TO THE SCOPE OF THE PROJECT IN WORKING ORDER.
- CONTRACTOR SHALL REMOVE LAY-IN CEILINGS, LIGHT FIXTURES, ETC. AS REQUIRED FOR CONSTRUCTION WHERE NEEDED PRIOR TO DEMOLITION AND REPLACE SAME AFTER CONSTRUCTION. EXISTING CONDUITS ABOVE CEILINGS SHALL BE RELOCATED AND/OR TEMPORARILY REMOVED TO FACILITATE THE INSTALLATION OF NEW EQUIPMENT.
- THE OWNER SHALL REMOVE ALL ITEMS THEY DESIRED TO SALVAGE PRIOR TO CONSTRUCTION BEGINNING.
- NOTES AND DRAWINGS ARE BASED UPON A FIELD EXAMINATION OF THE SITE AND MAY NOT INDICATE ALL ITEMS. THE CONTRACTOR SHALL VISIT THE SITE AND BECOME FAMILIAR WITH THE SITE AND THE SCOPE OF WORK FOR THE CONTRACT PRIOR TO BID. ANY EXISTING CONDITION WHICH IS APPARENT OR SHOULD BE REASONABLY INFERRED FROM A VISIT TO THE SITE SHALL NOT BE THE BASIS FOR A CHANGE IN THE CONTRACT AMOUNT.
- REFER TO NEW WORK PLANS FOR ANY ITEMS THAT MAY REQUIRE RELOCATION AFTER DEMOLITION.
- PROPERLY DISPOSE OF ALL DEMOLISHED ITEMS OFF SITE.
- REMOVE ALL MISCELLANEOUS CONDUITS, PIPES, ETC. THOUGH NOT SPECIFICALLY SHOWN ON PLAN, THAT ARE EITHER UNUSED OR WILL BECOME UNUSED DUE DEMOLITION ACTIVITIES, IN ORDER TO PROVIDE A "CLEAN" SPACE FOR THE OWNER.
- PROTECT ALL EXISTING SURFACES AND EQUIPMENT DURING CONSTRUCTION. EXISTING ITEMS TO REMAIN SHALL BE ADEQUATELY PROTECTED FROM DEMOLITION AND NEW CONSTRUCTION WORK, AS REQUIRED. ANY ITEMS DAMAGED OR MARRED SHALL BE ADEQUATELY CLEANED OR REPLACED TO THE OWNER'S SATISFACTION TO ORIGINAL CONDITION BEFORE CONSTRUCTION.
- PATCH ANY HOLES IN STRUCTURE CREATED BY REMOVAL OF DUCTWORK, CONDUITS, PIPES, ETC.
- REMOVE ALL ITEMS SHOWN IN WALLS TO BE DEMOLISHED. ALL ELECTRICAL CONDUIT AND WIRING SHALL BE REMOVED BACK TO PANELBOARDS AND/OR TERMINATED.
- SAVE OUT FLOOR FOR THE INSTALLATION OF NEW SANITARY PIPING. REFER TO PLUMBING PLANS SHOWING NEW WORK.
- SAVE, CLEAN, AND RE-LAMP ALL LIGHT FIXTURES NOTED AS BEING RELOCATED. REFER TO NEW WORK PLANS AND LIGHT FIXTURE SCHEDULE FOR DESCRIPTIONS, QUANTITIES, AND LOCATIONS OF FIXTURES TO BE RE-USED.

## COORDINATION NOTES

- COORDINATE REQUIREMENTS FOR INSTALLATION OF SYSTEMS AND EQUIPMENT WITH ALL OTHER TRADES.
- THE CONTRACTOR SHALL COORDINATE THE ROUTING AND PATH OF ALL SYSTEMS, CONDUITS, PIPES, DUCTS, ETC WITH THE POSITION AND LAYOUT OF THE STRUCTURE. THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING NECESSARY OFFSETS, TURNS, RISES AND DROPS FOR SYSTEMS AND COMPONENTS AS NEEDED TO INSTALL THE MEP SYSTEMS TO CLEAR STRUCTURE, CEILINGS, ETC AND OTHER SYSTEMS IN POTENTIAL CONFLICT WITH ROUTING.
- COORDINATE WORK WITH OTHER TRADES TO INSTALL SYSTEMS ABOVE CEILING HEIGHTS INDICATED ON ARCHITECTURAL PLANS.
- CHECK SPACE REQUIREMENTS WITH OTHER TRADES AND STRUCTURE/CONSTRUCTION TO ENSURE THAT ALL MATERIALS AND EQUIPMENT CAN BE INSTALLED IN THE SPACE ALLOTTED INCLUDING FINISHED SUSPENDED CEILINGS AND OTHER SPACES, CHASES, ETC WITHIN THE BUILDING. MAKE MODIFICATIONS THERETO AS REQUIRED AND APPROVED.
- TRANSMIT TO OTHER TRADES ALL INFORMATION REQUIRED FOR WORK TO BE PROVIDED UNDER THEIR RESPECTIVE SECTIONS IN AMPLE TIME FOR INSTALLATION.
- WHEREVER WORK INTERCONNECTS WITH WORK OF OTHER TRADES, COORDINATE WITH THOSE TRADES TO ENSURE THAT ALL SUBCONTRACTORS HAVE THE INFORMATION NECESSARY SO THAT THEY MAY PROPERLY INSTALL ALL CONNECTIONS AND EQUIPMENT. IDENTIFY ALL ITEMS OF WORK THAT REQUIRE ACCESS SO THAT THE CEILING TRADE WILL KNOW WHERE TO INSTALL ACCESS DOORS AND PANELS.
- COORDINATE, PROJECT AND SCHEDULE WORK WITH OTHER TRADES IN ACCORDANCE WITH THE CONSTRUCTION SEQUENCE.
- DRAWINGS SHOW THE GENERAL RUNS OF CONDUITS, PIPING AND DUCTWORK AND APPROXIMATE LOCATION OF OUTLETS. ANY SIGNIFICANT CHANGES IN LOCATION OF ITEMS NECESSARY IN ORDER TO MEET FIELD CONDITIONS SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE ARCHITECT/ENGINEER AND RECEIVE HIS APPROVAL BEFORE SUCH ALTERATIONS ARE MADE. ALL SUCH MODIFICATIONS SHALL BE MADE WITHOUT ADDITIONAL COST TO THE OWNER.
- CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTION AND REPAIR OF SURFACES, AREAS AND PROPERTY THAT MAY BE DAMAGED AS A RESULT OF CONSTRUCTION ACTIVITIES.
- ADJUST LOCATION OF PIPING, DUCTWORK, ETC. TO PREVENT INTERFERENCES, BOTH ANTICIPATED AND ENCOUNTERED. DETERMINE THE EXACT ROUTE AND LOCATION OF EACH ITEM PRIOR TO FABRICATION. MAKE OFFSETS, TRANSITIONS AND CHANGES IN DIRECTION IN SYSTEMS AS REQUIRED TO MAINTAIN ADEQUATE CLEARANCES AND HEADROOM.
- WHEREVER THE WORK IS OF SUFFICIENT COMPLEXITY, PREPARE ADDITIONAL COORDINATION DRAWINGS AND ORGANIZE ON-SITE MEETINGS WITH ALL RELATED SUBCONTRACTORS TO COORDINATE THE WORK BETWEEN TRADES. DRAWINGS SHALL CLEARLY SHOW THE WORK AND ITS RELATION TO THE WORK OF OTHER TRADES, AND BE SUBMITTED FOR REVIEW PRIOR TO COMMENCING SHOP FABRICATION OR ERECTION IN THE FIELD.
- COORDINATE WITH LOCAL UTILITY PROVIDERS FOR THEIR REQUIREMENTS FOR SERVICE CONNECTIONS AND PROVIDE ALL NECESSARY PAYMENTS, MATERIALS, LABOR AND TESTING TO ACCOMPLISH THE WORK.
- COORDINATE THE MOUNTING OF SUSPENDED LIGHT FIXTURES UTILIZING INDIRECT LIGHT SO THAT CONDUIT, DUCTWORK, STRUCTURAL MEMBERS, ETC. ARE NOT LOCATED DIRECTLY ABOVE THE LIGHT FIXTURE. MAINTAIN A MINIMUM OF 24" CLEARANCE FROM THESE ITEMS WHENEVER POSSIBLE.

## GEN. MECHANICAL NOTES

- COMPLETE INSTALLATION SHALL BE IN ACCORDANCE WITH THE LATEST ADOPTED VERSION OF THE INTERNATIONAL MECHANICAL CODE, LOCAL AND STATE CODES, AND REQUIREMENTS OF THE A/E.
- ANY POWER FOR CONTROL SYSTEMS TO BE PROVIDED BY E/C IS INDICATED ON ELECTRICAL PLANS. ANY ADDITIONAL LINE VOLTAGE OR LOW VOLTAGE POWER REQUIRED BY THE M/C OR SUBCONTRACTORS TO HAVE A FULLY FUNCTIONING SYSTEM SHALL BE PROVIDED BY THE M/C CONTRACTOR OR SUBS.
- ALL EQUIPMENT SHALL BE ADEQUATELY AND PROPERLY SUPPORTED AND FASTENED FROM STRUCTURE.
- ALL EQUIPMENT AND ACCESSORIES INSTALLED IN CONCEALED SPACES REQUIRING ACCESS SHALL BE PROVIDED WITH ACCESS DOORS MEETING ANY FIRE REQUIREMENTS OF THE WALL/CEILING THEY ARE INSTALLED.
- EACH AIR HANDLING UNIT OVER 2000CFM SHALL BE PROVIDED WITH A SMOKE DETECTOR TO SHUT DOWN THE UNIT PER IMC 606 AS REQUIRED BY AHJ. COORDINATE WITH OTHER TRADES.
- START UP AND ADJUST ALL EQUIPMENT AND VERIFY ALL MECHANICAL SYSTEMS IN OPERATE IN ACCORDANCE WITH THEIR INTENDED PURPOSES. SUBMIT BALANCE AND START UP REPORTS TO THE A/E. REFER TO SPECIFICATIONS FOR ANY ADDITIONAL REQUIREMENTS.

## GENERAL PLUMBING NOTES

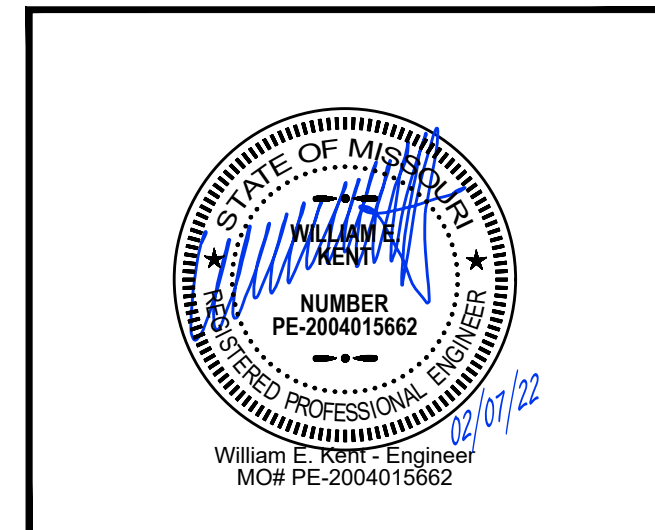
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- NO PIPING SHALL BE INSTALLED WHERE IT WILL SUBJECT TO FREEZING TEMPERATURES. PIPING IN EXTERIOR WALLS SHALL BE INSTALLED ON THE WARM SIDE OF BUILDING INSULATION, INSULATED AND THE CHASE SHALL BE VENTILATED WITH GRILLES ALLOWING INDOOR AMBIENT CONDITIONS TO CIRCULATE THROUGH THE CHASE.
- PROVIDE CLEANOUTS IN THE FOLLOWING LOCATIONS:
  - IN ALL HORIZONTAL DRAINS (WITHIN THE BUILDING) NOT MORE THAN 100 FEET APART.
  - IN BUILDING SEWERS LOCATED NO MORE THAN 100 FEET APART MEASURED FROM THE UPSTREAM ENTRANCE OF THE CLEANOUT.
  - EACH CHANGE OF DIRECTION OF THE BUILDING DRAIN OR HORIZONTAL WASTE OR SOIL LINES GREATER THAN 45 DEGREES WHERE MORE THAN ONE CHANGE OF DIRECTION OCCURS IN A RUN OF PIPING, ONLY ONE CLEANOUT SHALL BE REQUIRED FOR EACH 40 FEET OF DEVELOPED LENGTH OF THE DRAINAGE PIPING.
  - AT THE BASE OF EACH WASTE OR SOIL STACK.
  - NEAR THE JUNCTION OF THE BUILDING DRAIN AND BUILDING SEWER.

## GENERAL ELECTRICAL NOTES

- COMPLETE INSTALLATION SHALL BE IN ACCORDANCE WITH THE LATEST ADOPTED VERSION OF THE NATIONAL ELECTRICAL CODE, LOCAL AND STATE CODES, AND REQUIREMENTS OF THE A/E.
- COORDINATE LOCATIONS OF RECEPTACLES, SWITCHES, ETC. WITH ARCHITECTURAL CASEWORK AND ELEVATIONS.
- REFER TO MOUNTING HEIGHTS DETAIL FOR MOUNTING HEIGHTS OF ALL DEVICES NOT INDICATED OTHERWISE.
- PROVIDE ALL EMPTY CONDUITS WITH PULL STRINGS AND BUSHED ENDS.
- CONTRACTOR SHALL CONCEAL ALL CONDUIT, FITTINGS, AND DEVICES FROM VIEW WHERE REASONABLY POSSIBLE.
- REFER TO SPECIFICATIONS FOR ALLOWABLE WIRING METHODS THROUGHOUT PROJECT.
- ALL EXPOSED WIRING SHALL BE IN EMT OR METALLIC CONDUIT, EXCEPT AS PERMITTED BY SPECIFICATIONS FOR WHIPS TO EQUIPMENT.
- ALL CONDUCTOR SIZES INDICATED ON DRAWINGS ARE FOR COPPER CONDUCTORS UNLESS SPECIFICALLY NOTED OTHERWISE. ALUMINUM CONDUCTORS MAY BE USED ONLY UNDER THE FOLLOWING CONDITIONS:
  - CONTRACTOR SHALL INCLUDE A DEDUCT ALTERNATE FOR USE OF SAME WITH BIDS, FOR OWNER ACCEPTANCE.
  - AL CONDUCTORS MAY ONLY BE USED ON FEEDERS 100A OR GREATER - NO EXCEPTIONS.
  - ALUMINUM CABLEING SHALL BE COMPACTED ALUMINUM (STABILLOY).
  - PROVIDE COMPARTMENTS FOR EACH THROUGH-PENETRATION FIRESTOP SYSTEM THAT ARE NEEDED TO INSTALL FILL MATERIALS. USE ONLY COMPONENTS SPECIFIED BY THROUGH-PENETRATION FIRESTOP SYSTEM MANUFACTURER AND APPROVED BY QUALIFIED TESTING AND INSPECTING AGENCY FOR FIRESTOP SYSTEMS INDICATED.
  - PROVIDE SLEEVES THROUGH ALL FIRE-RATED WALLS AND FILL JOIDS SURROUNDING SLEEVES AND INTERIOR TO SLEEVES AROUND PIPING WITH FIRE STOP PUTTY WITH U.L. LISTED 3 HOUR RATING INSTALLED AS PER MANUFACTURER'S RECOMMENDATIONS.
  - FIRE SEAL ALL PIPING, CONDUIT, CABLE, ETC PENETRATIONS ROUTED THROUGH FIRE RATED WALLS.
  - PROVIDE FIRE RATED ENCLOSURES OR WRAPS ON LIGHT FIXTURES AND OTHER ITEMS PENETRATING FIRE RATED CEILINGS, FLOOR/CEILING/CEILING/ROOF ASSEMBLIES TO MAINTAIN UL LISTING FOR CONSTRUCTION.

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EMEP101B	MEP Lower Level - Area B
EMEP102A	MEP Middle Level - Area A
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SCHLAGLE HIGH SCHOOL	
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SMEP103	MEP Upper Level
SMEP104	MEP Penthouse Level
SMEP201	MEP Schedules and Details
SMEP202	MEP Control Schematics



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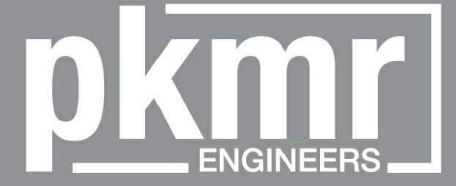
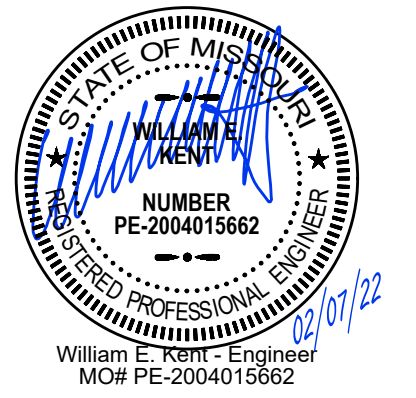
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WWW.PKMR.ENG.COM

# KANSAS CITY KANSAS PUBLIC SCHOOLS MECHANICAL UPGRADES MULTIPLE LOCATIONS KANSAS CITY, KANSAS

## ABBREVIATIONS

A/E	ARCHITECT / ENGINEER	ELEV	ELEVATION	MH	MANHOLE
AF	ABOVE FINISHED FLOOR	EM	EMERGENCY FIXTURE/DEVICE	MLO	MAIN LUGS ONLY
AFG	ABOVE FINISHED GRADE	EW	ENTERING WATER TEMPERATURE	NFA	NET FREE AREA
AG	ABOVE GRADE	EX	EXISTING ITEM	NL	NIGHT LIGHT
AHJ	AUTHORITY HAVING JURISDICTION	FFA	FROM FLOOR ABOVE	OA	OUTSIDE AIR
AHU	AIR HANDLING UNIT	FFB	FROM FLOOR BELOW	ORD	OVERFLOW ROOF DRAIN
ARCH	ARCHITECT	FFC	FINISHED FLOOR CLEAN OUT	P/C	PLUMBING CONTRACTOR
ARF	BACKFLOW PREVENTER	FOOD	FOUSH GRADE CLEAN OUT	PSI	POUNDS PER SQUARE INCH
BG	BELOW GRADE	FL	FLOOR LINE	PVC	POLYVINYLCHLORIDE
BLDG	BUILDING	FLR	FLOOR	RA	RETURN AIR
BMS	BUILDING MANAGEMENT SYSTEM	FP	FIRE PROTECTION	RE/REF	REFER / REFERENCE
C	CONDUIT	FPM	FEET PER MINUTE	RF	RELIEF FAN
CD	CANDELA	FWCO	FLUSH WALL CLEAN OUT	RL	RELOCATED ITEM
CD	COLD DECK	G	GROUND / GANG	RPZ	REDUCED PRESSURE ZONE
CL	COOLING	GC	GENERAL CONTRACTOR	RS	RESTROOM
CM	COORDINATE MOUNTING HEIGHT	GI	GROUND FAULT CIRCUIT INTERRUPTER	SA	SUPPLY AIR
CO	CLEAN OUT	GFP	GFI-PROTECTED DEVICE	SPD	SURGE PROTECTIVE DEVICE
CTE	CONNECT TO EXISTING	GPM	GALLONS PER MINUTE	ST	SHUNT TRIP
DCVA	DOUBLE CHECK VALVE ASSEMBLY	HD	HOT DECK	TA	TRANSFER AIR
DCW	DOMESTIC COLD WATER	HTG	HEATING	TFA	TO FLOOR ABOVE
DDC	DIRECT DIGITAL CONTROLS	IG	ISOLATED GROUND	TFB	TO FLOOR BELOW
DF	DRINKING FOUNTAIN	JB	JUNCTION BOX	TYP	TAMPERPROOF
DHW	DOMESTIC HOT WATER	LED	LIGHT EMITTING DIODE	TYP	TYPICAL
DHWR	DOMESTIC HOT WATER RETURN	LWT	LEAVING WATER TEMPERATURE	UNL	UNLESS NOTED OTHERWISE
DIA	DIAMETER	LWT	LEAVING WATER TEMPERATURE	VRF	VARIABLE REFRIGERANT FLOW
DN	DOWN	MA	MIXED AIR	VTR	VENT THROUGH ROOF
E/C	ELECTRICAL CONTRACTOR	MAU	MAKE UP AIR UNIT	WCO	WALL CLEANOUT
EA	EXHAUST AIR	MCB	MAIN CIRCUIT BREAKER	WG	WIRE GUARD
EDF	ELECTRIC DRINKING FOUNTAIN	MECH	MECHANICAL	WP	WEATHERPROOF

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SHEET NUMBER: MEP001	



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**GENERAL HVAC NOTES**

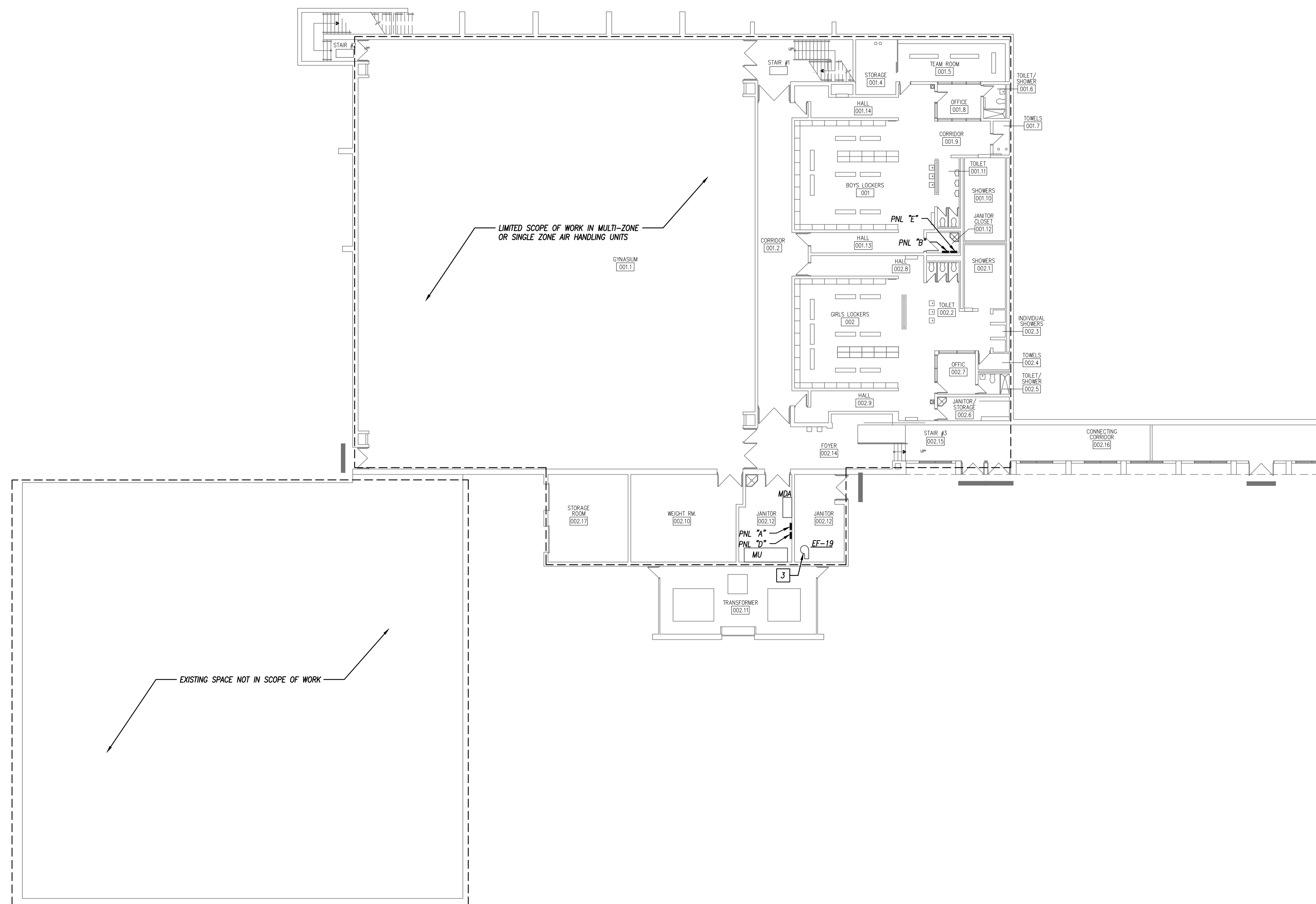
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  6. REPLACE EXISTING THERMOSTAT TO COMMUNICATE WITH BUILDING CONTROLS. USE EXISTING THERMOSTAT LOCATION FOR NEW THERMOSTAT. REPAIR AND PATCH ANY HOLES TO MATCH EXISTING CONSTRUCTION. TYPICAL FOR ALL THERMOSTAT LOCATIONS.

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**MEP LOWER LEVEL PLAN - AREA A**  
 1/16" = 1'-0"

**KANSAS CITY KANSAS PUBLIC SCHOOLS**  
**MECHANICAL UPGRADES**  
 EISENHOWER MIDDLE SCHOOL  
 2901 N 72ND STREET  
 KANSAS CITY, KANSAS 66109

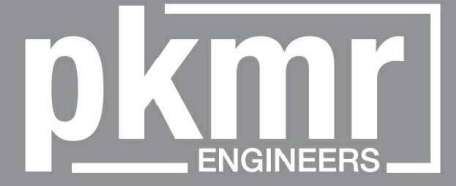
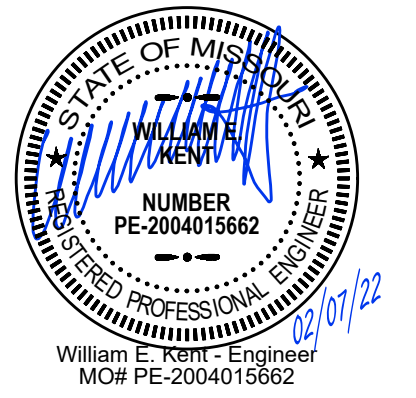
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**GENERAL HVAC NOTES**

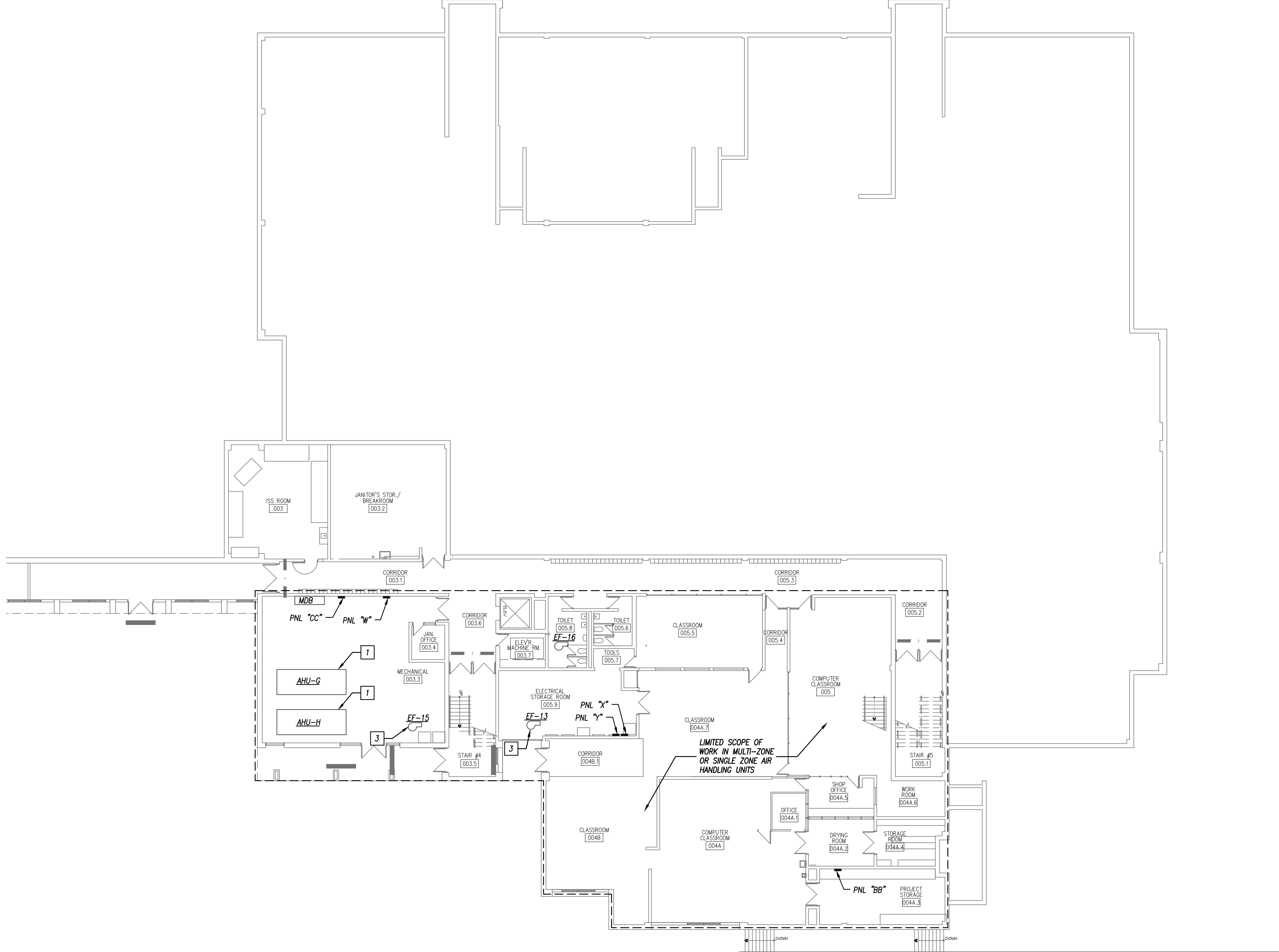
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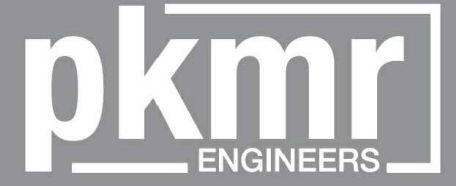
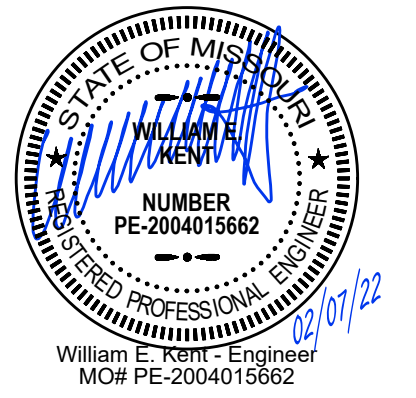
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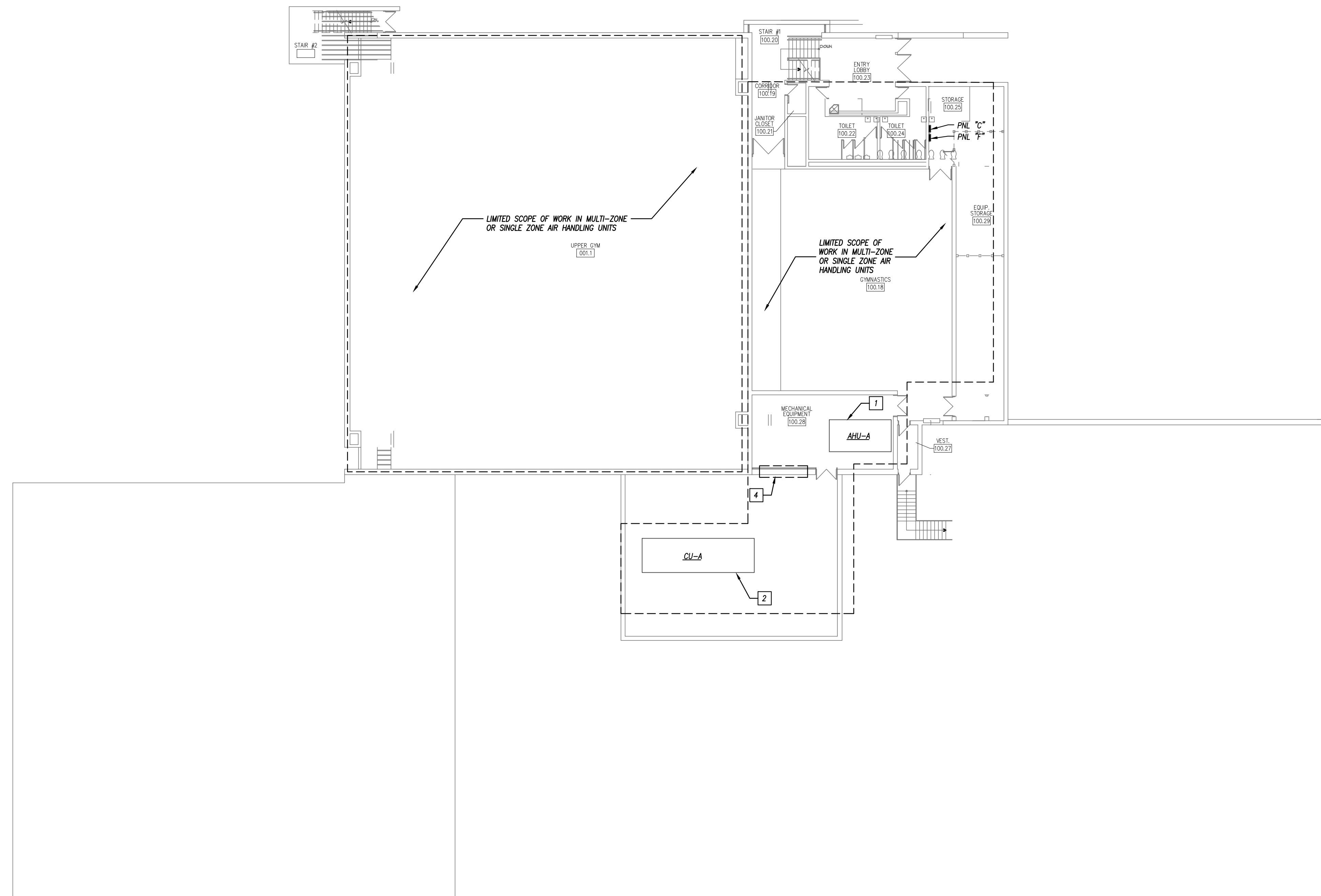
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  3. PROVIDE POWER TO DIGITAL CONTROLS ON TERMINAL UNITS TO BE ROUTED FROM MOST NEAR PANEL. PROVIDE MULTIPLE TERMINAL UNITS ON SAME CIRCUIT AND PANEL WHERE POSSIBLE.
  4. REMOVE AND REPLACE EXISTING TEMPERATURE SENSOR FOR NEW DDC CONTROLS.
  5. REMOVE AND REPLACE CEILING AS REQUIRED FOR REPLACEMENT OF TERMINAL UNITS. WHERE CEILING TILE AND GRID IS DAMAGE, REPLACE WITH NEW TO MATCH EXISTING CONSTRUCTION.



**MEP MIDDLE LEVEL PLAN - AREA A**  
 1/16" = 1'-0"

**KANSAS CITY KANSAS PUBLIC SCHOOLS**  
**MECHANICAL UPGRADES**  
 EISENHOWER MIDDLE SCHOOL  
 2901 N 72ND STREET  
 KANSAS CITY, KANSAS 66109

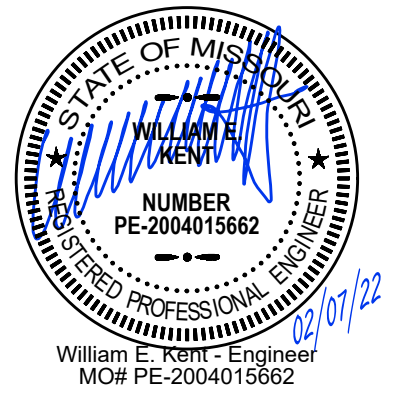
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SHEET TITLE:  
 MEP MIDDLE LEVEL - AREA A

DATE: **02/07/22** PKMR PROJECT: **21.659C**

SHEET NUMBER:



PEARSON KENT MCKINLEY RAAF ENGINEERS LLC  
 13300 W 98TH STREET  
 LENEXA, KS 66215  
 913.492.2400  
 WWW.PKMRENG.COM

**GENERAL HVAC NOTES**

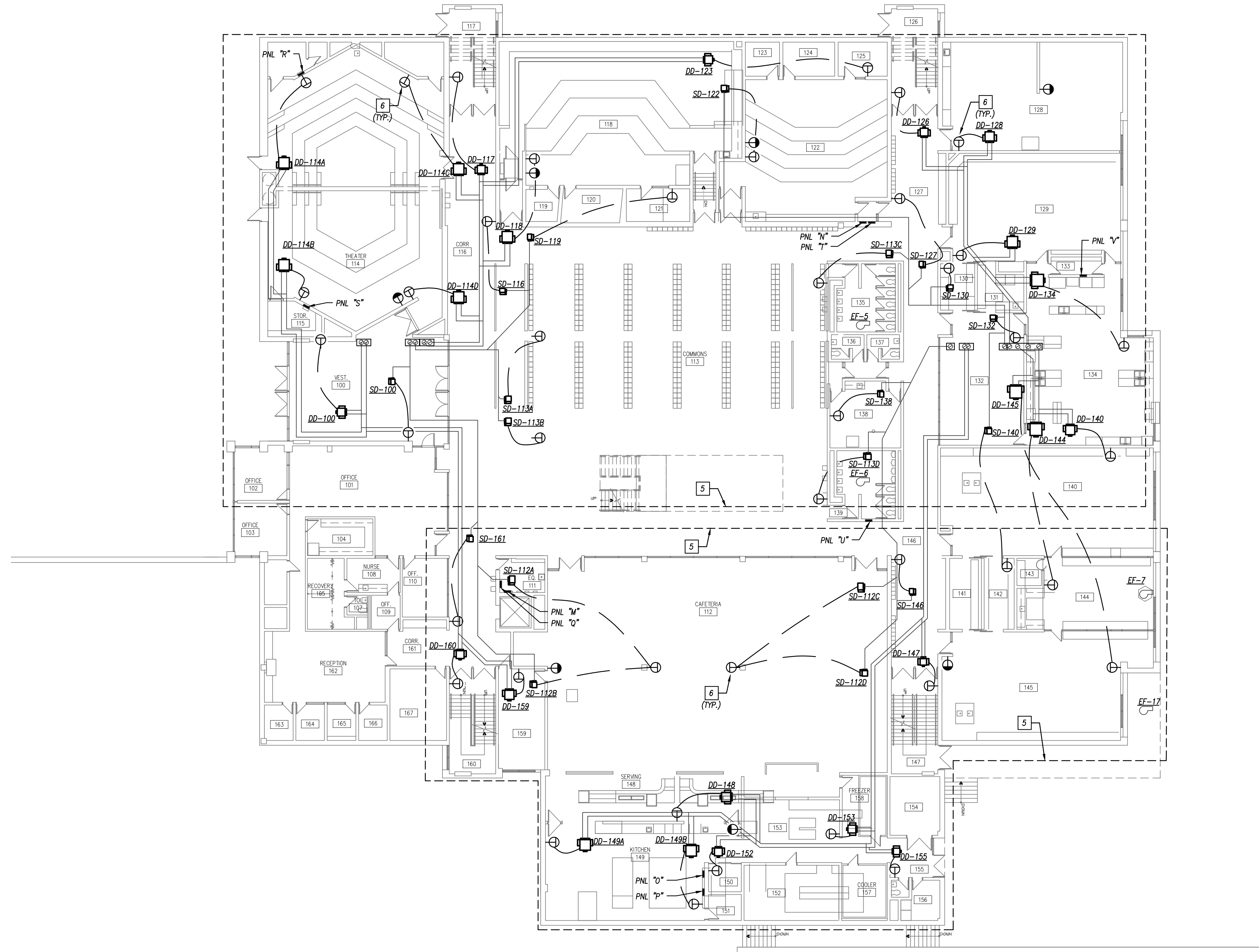
1. REFER TO GENERAL NOTES ON MEP COVER SHEET FOR ADDITIONAL REQUIREMENTS OF WORK.
2. ROUND BRANCH DUCT RUNOUTS AND FLEXIBLE DUCT SHALL BE THE SAME SIZE AS THE DIFFUSER NECK UNLESS NOTED OTHERWISE.
3. MAXIMUM FLEXIBLE DUCT LENGTH SHALL BE 5'-0".
4. ALL RUNOUTS TO TERMINAL BOXES SHALL BE ONE SIZE LARGER THAN BOX INLETS UNLESS NOTED OTHERWISE.
5. ALL AIR DISTRIBUTION DEVICES SHALL HAVE LOCKABLE VOLUME CONTROL DEVICES.
6. DUCT SIZES SHOWN ON PLANS ARE INSIDE FREE AREA.
7. FOR BALANCING THE OUTSIDE AIRFLOW QUANTITIES, REFER TO HVAC SCHEDULES.

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**MEP MIDDLE LEVEL PLAN - AREA B**  
 1/16" = 1'-0"

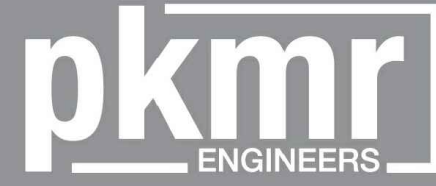
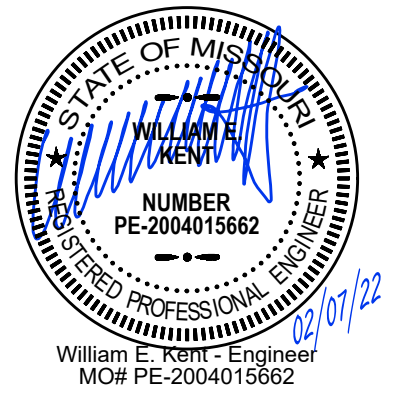
**KANSAS CITY KANSAS PUBLIC SCHOOLS  
 MECHANICAL UPGRADES**  
 EISENHOWER MIDDLE SCHOOL  
 2901 N 72ND STREET  
 KANSAS CITY, KANSAS 66109

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 MEP MIDDLE LEVEL - AREA B

DATE: **02/07/22** PKMR PROJECT: **21.659C**  
 SHEET NUMBER:



PEARSON KENT MCKINLEY RAAF ENGINEERS LLC  
 13300 W 98TH STREET LENEXA, KS 66215  
 913.492.2400 WWW.PKMRENG.COM

**GENERAL HVAC NOTES**

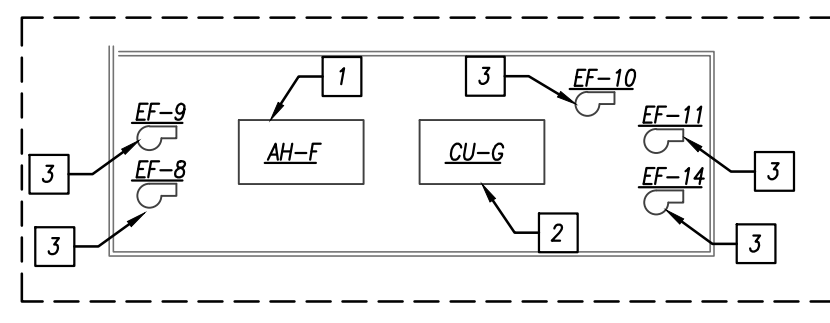
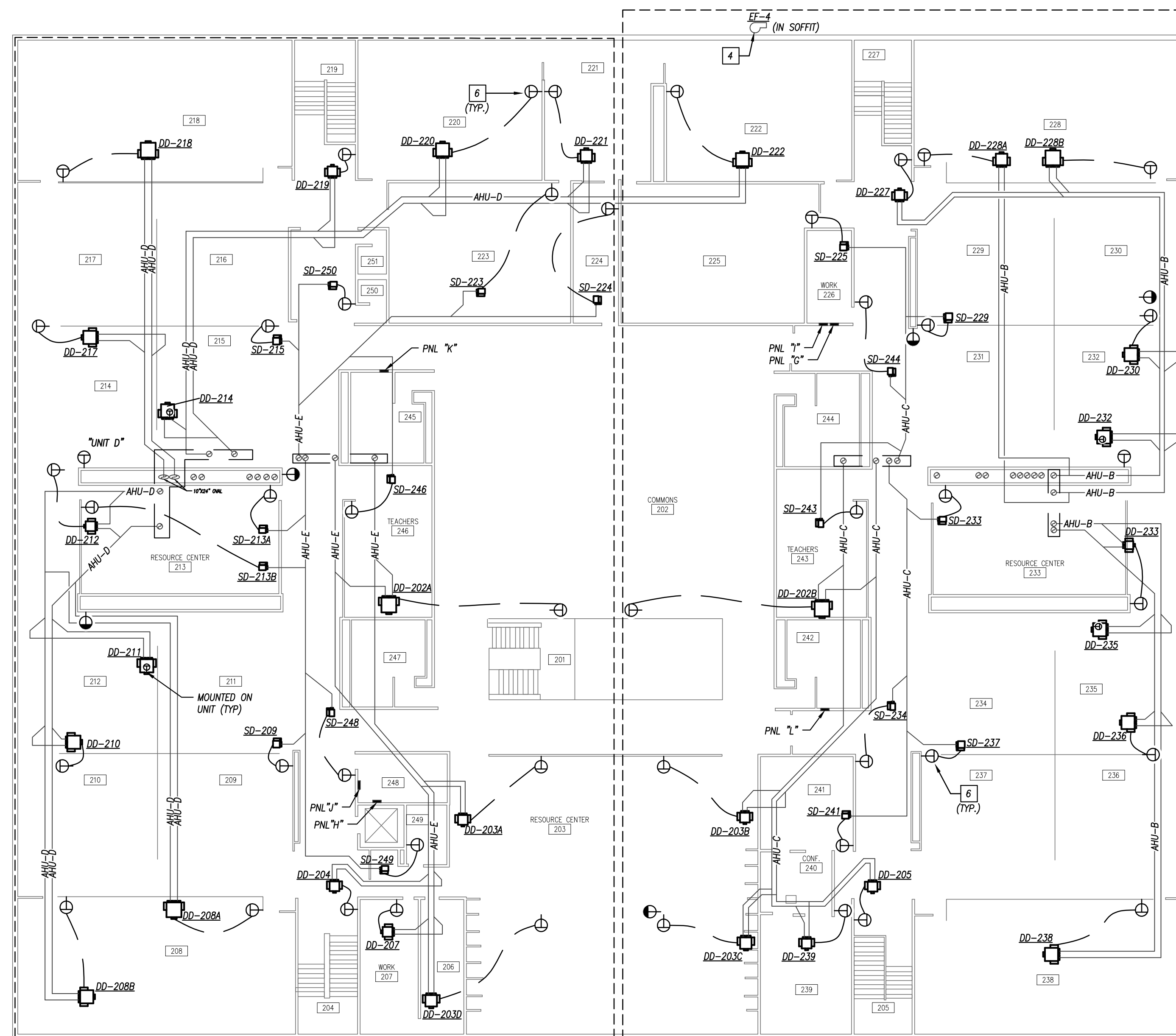
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 MECHANICAL UPGRADES**  
 EISENHOWER MIDDLE SCHOOL  
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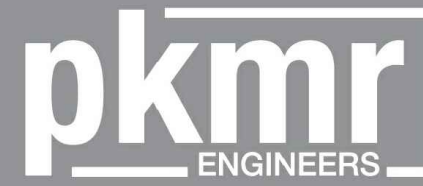
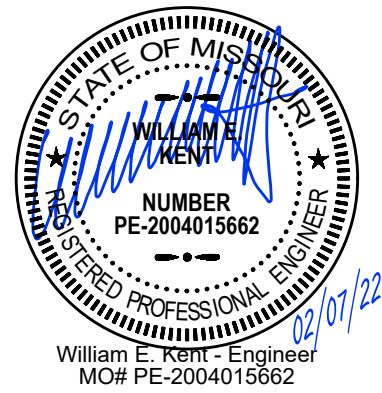
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 MEP UPPER LEVEL

DATE: **02/07/22** PKMR PROJECT: **21.659C**

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**GENERAL HVAC NOTES**

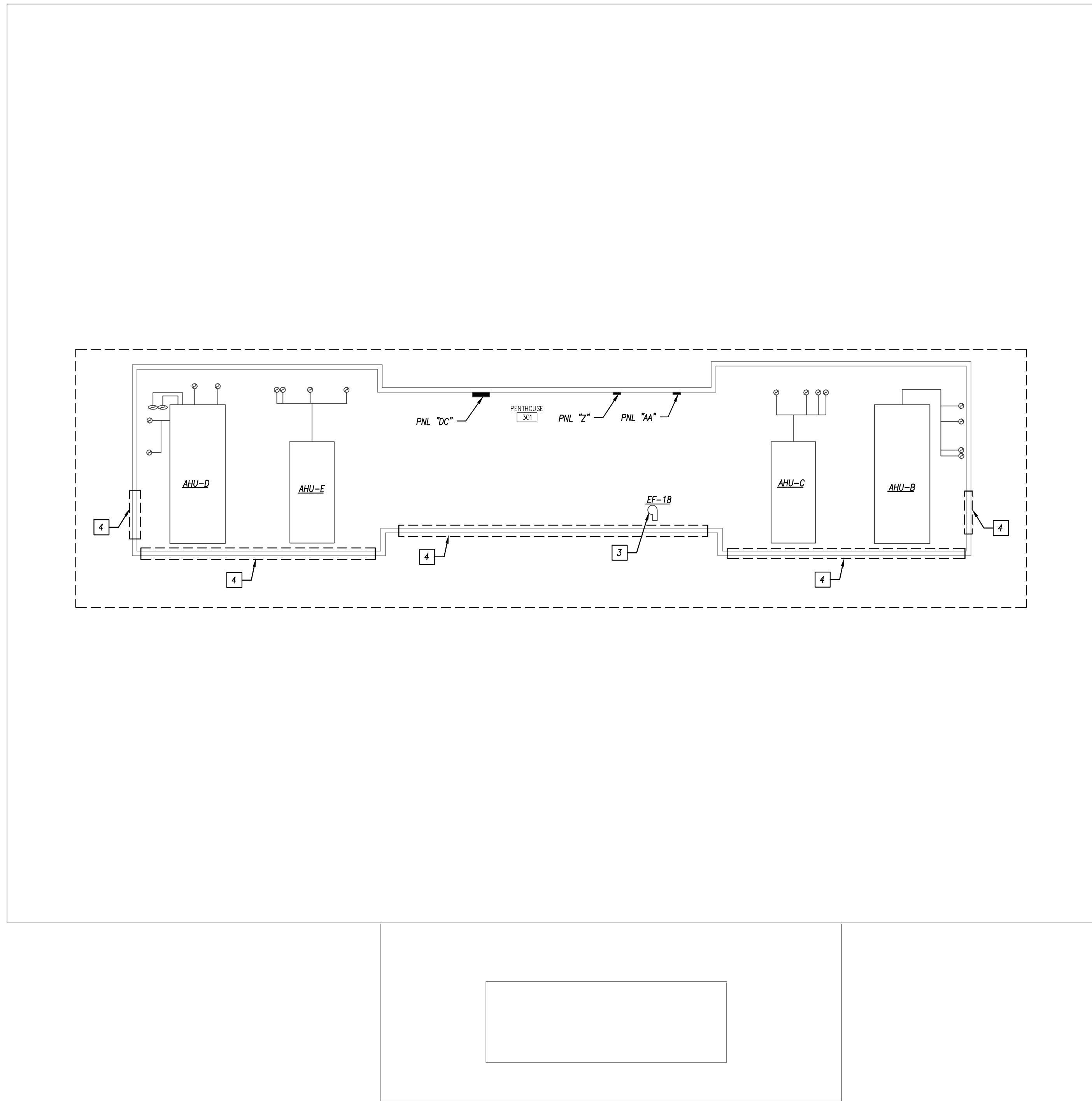
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 1/16" = 1'-0"

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**MECHANICAL UPGRADES**  
 EISENHOWER MIDDLE SCHOOL  
 2901 N 72ND STREET  
 KANSAS CITY, KANSAS 66109

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 MEP PENTHOUSE LEVEL

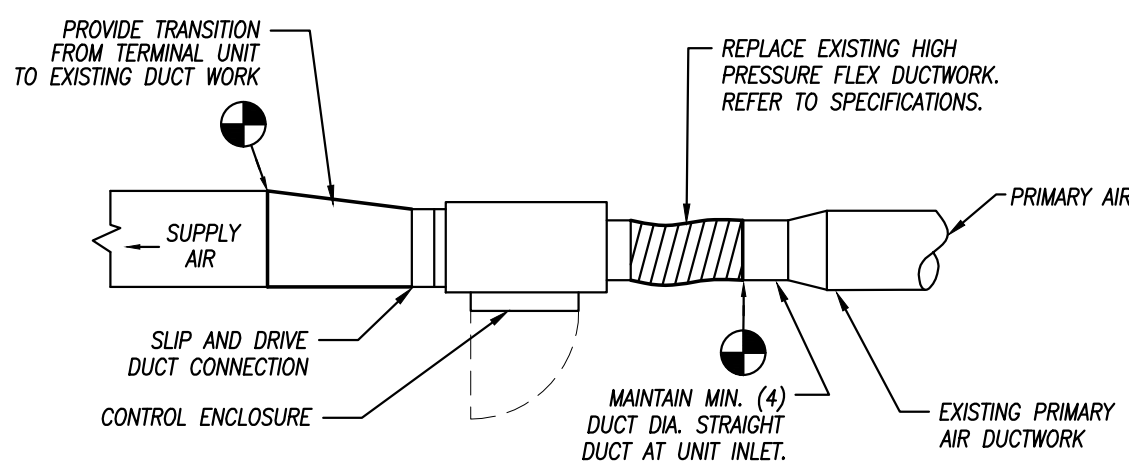
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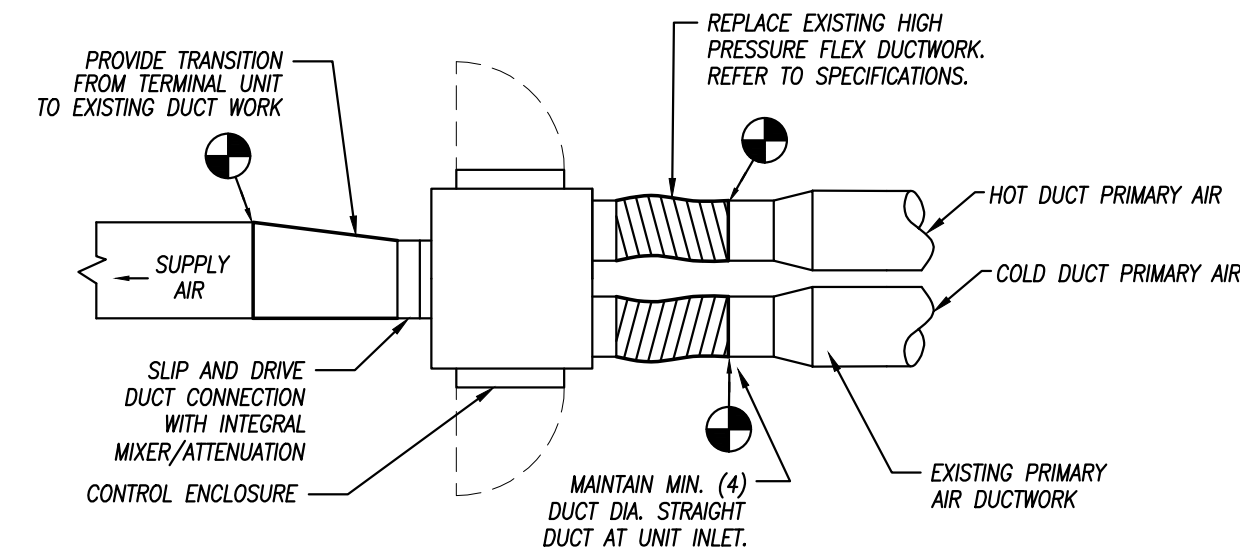
**DUAL DUCT BOX SCHEDULE**

PLAN MARK	AHU SERVED	ROOM NUMBER	MANUFACTURER	MODEL NUMBER	INLET SIZE		PRIMARY CFM		MINIMUM CFM	REMARKS
					COLD	HOT	COLD	HOT		
DD-100	AHU-D	100	TITUS	DEDV	8"	8"	650	488	98	ALL
DD-114A	AHU-D	114	TITUS	DEDV	12"	12"	1,250	938	188	ALL
DD-114B	AHU-D	114	TITUS	DEDV	12"	12"	1,250	938	188	ALL
DD-114C	AHU-D	114	TITUS	DEDV	12"	12"	1,250	938	188	ALL
DD-114D	AHU-D	114	TITUS	DEDV	12"	12"	1,250	938	188	ALL
DD-117	AHU-D	117	TITUS	DEDV	8"	8"	565	424	85	ALL
DD-118	AHU-D	118	TITUS	DEDV	12"	12"	2,200	1,650	330	ALL
DD-123	AHU-D	123, 124, 125	TITUS	DEDV	8"	8"	760	570	114	ALL
DD-126	AHU-B	126	TITUS	DEDV	8"	8"	565	424	85	ALL
DD-128	AHU-B	128	TITUS	DEDV	10"	10"	1,250	938	188	ALL
DD-129	AHU-B	129	TITUS	DEDV	12"	12"	1,280	960	192	ALL
DD-134	AHU-B	134	TITUS	DEDV	14"	14"	2,350	1,763	353	ALL
DD-140	AHU-B	140	TITUS	DEDV	10"	10"	960	720	144	ALL
DD-144	AHU-B	144	TITUS	DEDV	14"	14"	1,400	1,050	210	ALL
DD-145	AHU-B	145	TITUS	DEDV	14"	14"	1,410	1,058	212	ALL
DD-147	AHU-B	147	TITUS	DEDV	5"	5"	300	225	45	ALL
DD-148	AHU-B	148	TITUS	DEDV	10"	10"	1,050	788	158	ALL
DD-149A	AHU-B	149	TITUS	DEDV	12"	12"	1,690	1,268	254	ALL
DD-149B	AHU-B	149	TITUS	DEDV	12"	12"	1,690	1,268	254	ALL
DD-152	AHU-B	150, 151, 152	TITUS	DEDV	8"	8"	570	428	86	ALL
DD-153	AHU-B	153	TITUS	DEDV	8"	8"	600	450	90	ALL
DD-155	AHU-B	155, 156	TITUS	DEDV	8"	8"	400	300	60	ALL
DD-159	AHU-D	159	TITUS	DEDV	10"	10"	940	705	141	ALL
DD-160	AHU-D	160	TITUS	DEDV	8"	8"	565	424	85	ALL
DD-202A	AHU-E	202, 247	TITUS	DEDV	14"	14"	2,750	2,063	413	ALL
DD-202B	AHU-C	202, 242	TITUS	DEDV	14"	14"	2,750	2,063	413	ALL
DD-203A	AHU-E	203	TITUS	DEDV	8"	8"	730	548	110	ALL
DD-203B	AHU-C	203	TITUS	DEDV	8"	8"	740	555	111	ALL
DD-203C	AHU-C	203	TITUS	DEDV	10"	10"	945	709	142	ALL
DD-203D	AHU-E	203	TITUS	DEDV	10"	10"	930	698	140	ALL
DD-204	AHU-E	204	TITUS	DEDV	8"	8"	525	394	79	ALL
DD-205	AHU-C	205	TITUS	DEDV	8"	8"	525	394	79	ALL
DD-207	AHU-E	206, 207	TITUS	DEDV	8"	8"	800	600	120	ALL
DD-208A	AHU-D	208	TITUS	DEDV	14"	14"	1,900	1,425	285	ALL
DD-208B	AHU-D	208	TITUS	DEDV	12"	12"	1,300	975	195	ALL
DD-210	AHU-D	210	TITUS	DEDV	12"	12"	2,140	1,605	321	ALL
DD-211	AHU-D	211	TITUS	DEDV	12"	12"	2,000	1,500	300	ALL
DD-212	AHU-D	212	TITUS	DEDV	8"	8"	540	405	81	ALL
DD-214	AHU-D	214	TITUS	DEDV	12"	12"	2,000	1,500	300	ALL
DD-217	AHU-D	217	TITUS	DEDV	12"	12"	2,140	1,605	321	ALL
DD-218	AHU-D	218	TITUS	DEDV	14"	14"	2,520	1,890	378	ALL
DD-219	AHU-D	219	TITUS	DEDV	8"	8"	525	394	79	ALL
DD-220	AHU-D	220	TITUS	DEDV	12"	12"	1,480	1,110	222	ALL
DD-221	AHU-D	221	TITUS	DEDV	10"	10"	875	656	131	ALL
DD-222	AHU-D	222	TITUS	DEDV	12"	12"	1,480	1,110	222	ALL
DD-227	AHU-B	227	TITUS	DEDV	8"	8"	525	394	79	ALL
DD-228A	AHU-B	228	TITUS	DEDV	10"	10"	1,170	878	176	ALL
DD-228B	AHU-B	228	TITUS	DEDV	14"	14"	2,100	1,575	315	ALL
DD-230	AHU-B	230, 232	TITUS	DEDV	12"	12"	1,690	1,268	254	ALL
DD-232	AHU-B	229, 230, 231, 232	TITUS	DEDV	12"	12"	2,000	1,500	300	ALL
DD-233	AHU-B	233	TITUS	DEDV	5"	5"	300	225	45	ALL
DD-235	AHU-B	234, 235, 236, 237	TITUS	DEDV	12"	12"	2,000	1,500	300	ALL
DD-236	AHU-B	235, 236	TITUS	DEDV	12"	12"	1,690	1,268	254	ALL
DD-238	AHU-B	238	TITUS	DEDV	12"	12"	1,975	1,481	296	ALL
DD-239	AHU-C	239	TITUS	DEDV	8"	8"	545	409	82	ALL

- REMARKS:**
1. INSTALL HIGH PRESSURE FLEXIBLE DUCT CONNECTORS AT INLETS.
  2. PROVIDE FACTORY INSTALLED CONTROL POWER TRANSFORMER.
  3. PROVIDE PRESSURE INDEPENDENT, DDC CONTROL PACKAGE.
  4. PROVIDE WITH INTEGRAL MIXER /ATTENUATOR.
  5. PROVIDE UNITS SIZE EQUAL TO OR LESS THAN 80% OF MANUFACTURER'S MAXIMUM AIR FLOW.



**VAV TERMINAL BOX DETAIL**  
NOT TO SCALE



**DUAL-DUCT TERMINAL BOX DETAIL**  
NOT TO SCALE

**SINGLE DUCT BOX SCHEDULE**

PLAN MARK	AHU SERVED	ROOM NUMBER	MANUFACTURER	MODEL NUMBER	INLET SIZE	PRIMARY CFM	MINIMUM CFM	REMARKS
SD-112A	AHU-D	112	TITUS	DESV	14"	2,040	306	ALL
SD-112B	AHU-E	112	TITUS	DESV	10"	1,170	176	ALL
SD-112C	AHU-C	112	TITUS	DESV	14"	1,940	291	ALL
SD-112D	AHU-C	112	TITUS	DESV	12"	1,370	206	ALL
SD-113A	AHU-E	113	TITUS	DESV	12"	1,600	240	ALL
SD-113B	AHU-E	113	TITUS	DESV	12"	1,600	240	ALL
SD-113C	AHU-C	113, 135	TITUS	DESV	12"	1,340	201	ALL
SD-113D	AHU-C	113, 139	TITUS	DESV	12"	1,340	201	ALL
SD-116	AHU-E	116	TITUS	DESV	8"	500	75	ALL
SD-119	AHU-E	119, 120, 121	TITUS	DESV	8"	530	80	ALL
SD-122	AHU-C	122	TITUS	DESV	12"	1,350	203	ALL
SD-127	AHU-C	127	TITUS	DESV	6"	500	75	ALL
SD-130	AHU-C	130, 131	TITUS	DESV	6"	350	53	ALL
SD-132	AHU-C	132	TITUS	DESV	8"	600	90	ALL
SD-138	AHU-C	138	TITUS	DESV	6"	260	39	ALL
SD-140	AHU-C	140, 142, 143	TITUS	DESV	10"	890	134	ALL
SD-146	AHU-C	146	TITUS	DESV	6"	500	75	ALL
SD-161	AHU-E	161	TITUS	DESV	6"	500	75	ALL
SD-209	AHU-E	209, 211	TITUS	DESV	12"	1,360	204	ALL
SD-213A	AHU-E	213	TITUS	DESV	8"	400	60	ALL
SD-213B	AHU-E	213	TITUS	DESV	8"	400	60	ALL
SD-215	AHU-D	215, 216	TITUS	DESV	12"	1,360	204	ALL
SD-223	AHU-E	223	TITUS	DESV	8"	800	120	ALL
SD-224	AHU-E	224	TITUS	DESV	4"	250	38	ALL
SD-225	AHU-C	225, 226	TITUS	DESV	10"	950	143	ALL
SD-229	AHU-C	229, 231	TITUS	DESV	12"	1,350	203	ALL
SD-233	AHU-C	233	TITUS	DESV	8"	740	111	ALL
SD-234	AHU-C	E CORR.	TITUS	DESV	6"	500	75	ALL
SD-237	AHU-C	234, 237	TITUS	DESV	12"	1,350	203	ALL
SD-241	AHU-C	240, 241	TITUS	DESV	6"	440	66	ALL
SD-243	AHU-C	243	TITUS	DESV	6"	380	57	ALL
SD-244	AHU-C	E CORR.	TITUS	DESV	6"	500	75	ALL
SD-246	AHU-E	246	TITUS	DESV	6"	380	57	ALL
SD-248	AHU-E	W CORR.	TITUS	DESV	6"	500	75	ALL
SD-249	AHU-E	248, 249	TITUS	DESV	5"	235	35	ALL
SD-250	AHU-E	250, 251, W CORR.	TITUS	DESV	8"	600	90	ALL

- REMARKS:**
1. INSTALL HIGH PRESSURE FLEXIBLE DUCT CONNECTORS AT INLETS.
  2. PROVIDE FACTORY INSTALLED CONTROL POWER TRANSFORMER (120V-277V/50A)+UNIT CONTROLLER
  3. PROVIDE PRESSURE INDEPENDENT, DDC CONTROL PACKAGE
  4. PROVIDE WITH INTEGRAL MIXER /ATTENUATOR.
  5. PROVIDE UNITS SIZE EQUAL TO OR LESS THAN 80% OF MANUFACTURER'S MAXIMUM AIR FLOW.

**EXHAUST FAN SCHEDULE**

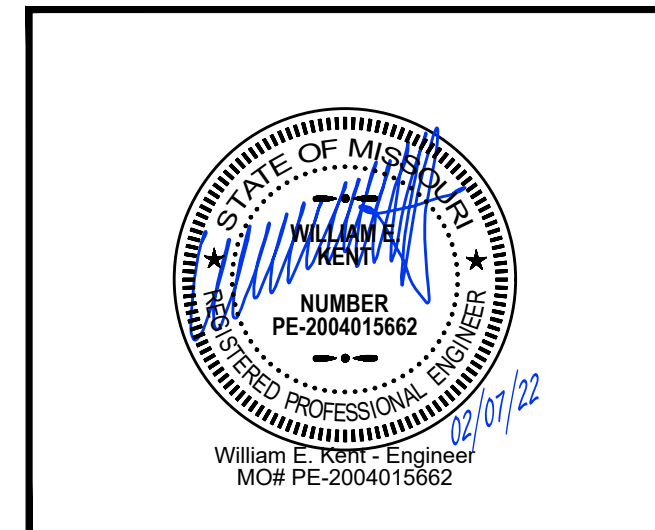
PLAN MARK	MANUFACTURER	AREA SERVED	FAN DATA		CONTROL	NOTES	REMARKS
			CFM	E.S.P. (IN)			
EF-1	EXISTING	LOCKERS	6,200	0.375	DDC - STATUS		1
EF-2	EXISTING	GYM RELIEF	12,850	0.375	DDC - STATUS		1
EF-3	EXISTING	GYM RELIEF	12,850	0.375	DDC - STATUS		1
EF-4	EXISTING	FUME HOOD	380	0.375	---	EXISTING TO REMAIN	2
EF-5	EXISTING	SOUTH TOLIET	3,210	0.375	DDC - STATUS		1
EF-6	EXISTING	NORTH TOLIET	5,320	0.375	DDC - STATUS		1
EF-7	EXISTING	KLM HOOD	525	0.250	---	EXISTING TO REMAIN	2
EF-8	EXISTING	KITCHEN HOOD	6,000	1,500	---	EXISTING TO REMAIN	2
EF-9	EXISTING	KITCHEN HOOD	1,725	1,500	---	EXISTING TO REMAIN	2
EF-10	EXISTING	DISHWASH	1,700	0.500	---	EXISTING TO REMAIN	2
EF-11	EXISTING	KITCHEN	1,300	0.375	DDC - STATUS		1
EF-12	EXISTING	LOWER LEVEL TOLIET	1,100	0.250	DDC - STATUS		1
EF-13	EXISTING	WELDING	3,600	0.500	---	EXISTING TO REMAIN	2
EF-14	EXISTING	DARK ROOM	1,000	0.375	---	EXISTING TO REMAIN	2
EF-15	EXISTING	MECH. LOWER LEVEL	2,500	0.250	DDC - STATUS		1
EF-16	EXISTING	OFFICE TOLIET	200	0.250	---	EXISTING TO REMAIN	2
EF-17	EXISTING	ART WORK	145	0.250	---	EXISTING TO REMAIN	2
EF-18	EXISTING	PENTHOUSE	7,500	0.250	---	EXISTING TO REMAIN	2
EF-19	EXISTING	ELECTRICAL ROOM	600	0.375	---	EXISTING TO REMAIN	2

- REMARKS:**
1. FIELD VERIFY OPERATING CHARACTERISTICS OF ALL EXISTING FANS. BALANCE EACH TO CFM INDICATED. PROVIDE NEW SHEAVES AS REQUIRED. REPLACE ALL BELTS, LUBRICATE ALL FAN BEARINGS, AND CLEAN ALL FAN HOUSINGS AND WHEELS.
  2. EXISTING FAN AND CONTROLS TO REMAIN. NO DDC INTERFACE REQUIRED.

**AIR HANDLING UNIT SCHEDULE**

PLAN MARK	MANUFACTURER	UNIT ARRANGMENT	AREA SERVED	CFM	OA CFM	ELECTRICAL VOLTAGE/PHASE	NOTES
AHU-B	EXISTING	DUAL DUCT	NORTH PERIM.	34,110	3,300	460/3	ALL
AHU-C	EXISTING	VAV	NORTH CORE	16,650	3,900	460/3	ALL
AHU-D	EXISTING	DUAL DUCT	SOUTH PERIM.	35,325	3,675	460/3	ALL
AHU-E	EXISTING	VAV	SOUTH CORE	14,675	3,900	460/3	ALL
AHU-F	EXISTING	SINGLE ZONE	KITCHEN HOOD MAKE UP	6,000	6,000	460/3	ALL
AHU-G	EXISTING	MULTI ZONE	OFFICE	4,455	600	460/3	ALL
AHU-H	EXISTING	MULTI ZONE	LOWER LEVEL	11,855	4,600	460/3	ALL

- REMARKS:**
1. FIELD VERIFY ALL PHYSICAL AND OPERATING CHARACTERISTICS OF ALL AIR HANDLING EQUIPMENT. AIR FLOWS ARE ESTIMATED BASED ON ORIGINAL DESIGN DOCUMENTS AND NOT NECESSARILY REFLECT ACTUAL FIELD CONDITIONS.
  2. NO RPM DATA AVAILABLE - FIELD VERIFY.
  3. BALANCE EQUIPMENT TO AIR FLOW VALUES SHOWN.
  4. PRIOR TO TESTING AND BALANCING EQUIPMENT CONTRACTOR SHALL CLEAN ALL COILS, CORRECT ANY FIN DAMAGE, AND REPLACE FILTERS.



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**KANSAS CITY KANSAS PUBLIC SCHOOLS  
MECHANICAL UPGRADES**

**EISENHOWER MIDDLE SCHOOL  
2901 N 72ND STREET  
KANSAS CITY, KANSAS 66109**

ISSUED FOR:

DESCRIPTION	DATE
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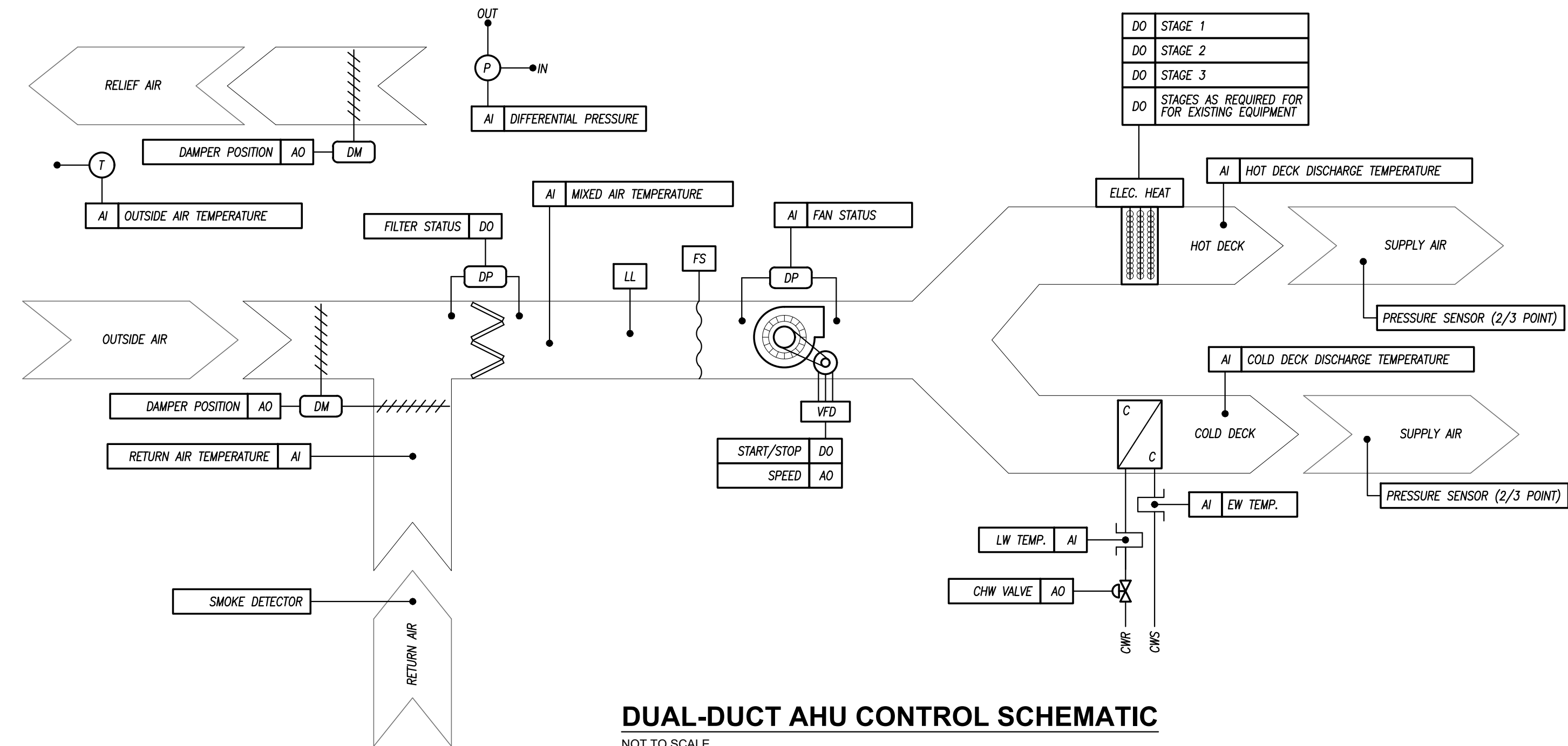
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MEP SCHEDULES AND DETAILS

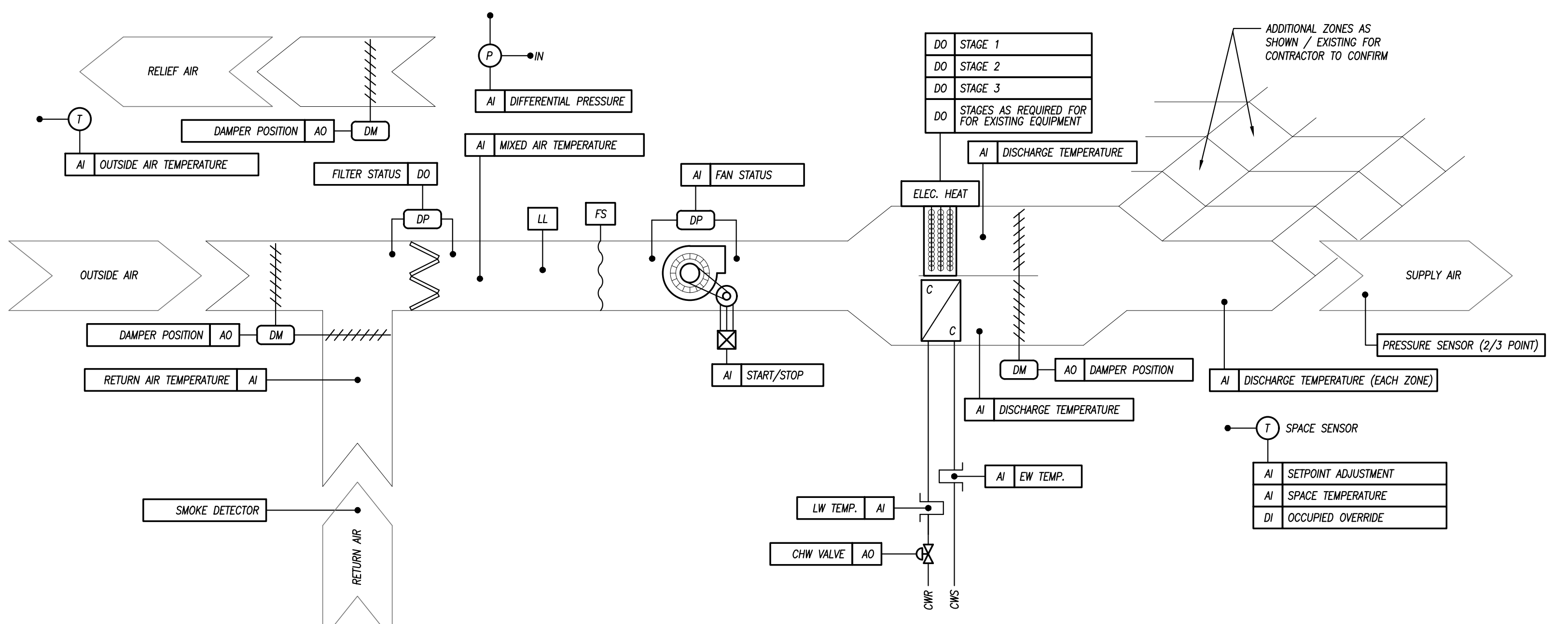
DATE: **02/07/22** PKMR PROJECT: **21.659C**

SHEET NUMBER:  
EMEP201

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**DUAL-DUCT AHU CONTROL SCHEMATIC**  
NOT TO SCALE



**MULTI-ZONE AIR AHU CONTROLS SCHEMATIC**  
NOT TO SCALE

**SEQUENCE OF OPERATION**

**DUAL DUCT AIR HANDLING UNITS - COLD AND HOT DECK**

THE UNITS WILL BE CYCLED ON A TIME OF DAY SCHEDULE OR FROM THE MANUAL OVERRIDE TIMER. THE UNIT START AND STOP TIMES WILL BE ADJUSTED BY THE OPTIMAL START/STOP PROGRAM.

OCCUPIED CYCLE: THE UNIT FAN WILL RUN CONTINUOUSLY AND THE OUTDOOR AIR DAMPER WILL OPEN TO ITS MINIMUM POSITION. THE CHILLED WATER VALVE, ELECTRIC DUCT HEATER (EDH), AND THE MIXED AIR DAMPERS WILL BE CONTROLLED IN THE SEQUENCE TO MAINTAIN A ROOM TEMPERATURE SET POINT OF 72°F. THE EDH WILL BE ENABLED WHEN THE OUTDOOR TEMPERATURE IS BELOW 55°F AND CONTROLLED BY THE HEATING DISCHARGE AIR TEMPERATURE SENSOR TO MAINTAIN A CONSTANT TEMPERATURE OF 55°F. THE MIXED AIR DAMPERS WILL BE MODULATED TO LIMIT THE MIXED AIR TEMPERATURE TO A MINIMUM TEMPERATURE OF 55°F.

WHEN CHILLED WATER IS AVAILABLE FOR COOLING AND THE OUTDOOR ENTHALPY IS LESS THAN THE RETURN AIR ENTHALPY, THE OUTDOOR AIR DAMPERS WILL BE OPEN FULL. IF THE OUTDOOR AIR ENTHALPY IS GREATER THAN THE RETURN AIR ENTHALPY OR THE OUTDOOR AIR TEMPERATURE IS ABOVE 75°F, THE DAMPERS WILL BE IN THEIR MINIMUM POSITION.

SHOULD THE CHILLED WATER COIL ENTERING AIR TEMPERATURE DROP BELOW 45°F, AN ALARM WILL SOUND. IF THE MIXED AIR TEMPERATURE FALLS BELOW 40°F, THE UNIT WILL BE SHUTDOWN BY THE LOW LIMIT THERMOSTAT AND A MANUAL RESET OF THERMOSTAT WILL BE REQUIRED FOR THE FAN TO RESTART. SHOULD THE FAN DISCHARGE AIR STATIC PRESSURE EXCEED 3" W.C., THE UNIT FAN WILL BE SHUTDOWN. THE FIRST TWO SHUTDOWNS WITHIN A TWO HOUR PERIOD WILL BE AUTOMATICALLY RESET AFTER A FIVE MINUTE DELAY. ON THE THIRD SHUTDOWN AN ALARM WILL SOUND AND A MANUAL RESET WILL BE REQUIRED TO RESTART THE FAN.

THE RTU WILL MODULATE THE OUTPUT TO THE VFD AS REQUIRED TO MAINTAIN THE DUCT STATIC PRESSURE OF 1.5" W.C. IF THE DUCT STATIC PRESSURE FALLS BELOW 1.3" W.C. (ADJ) THE RTU WILL INCREASE THE OUTPUT TO THE VFD TO MAINTAIN SETPOINT. IF THE DUCT STATIC PRESSURE RISES ABOVE 1.7" W.C. THE RTU WILL DECREASE THE OUTPUT TO THE VFD TO MAINTAIN SETPOINT. RESET STATIC PRESSURE SETPOINT BASED ON THE ZONE REQUIRING THE MOST PRESSURE. THE SUPPLY DUCT STATIC PRESSURE SENSOR WILL ALSO ACT AS A HIGH DUCT STATIC PRESSURE SAFETY AND WILL SHUTDOWN THE TRU IN THE EVENT THAT THE DUCT STATIC PRESSURE REACHES 3.0" W.C. (ADJ). A RESET WILL BE REQUIRED TO RESET THE RTU. IF THE DUCT STATIC PRESSURE SENSOR FAILS, THEN THE VFD WILL MODULATE ITS SPEED TO 50%, AN ALARM WILL BE ANNUNCIATED.

IF THE SPACE PRESSURE IS EQUAL TO THE PROGRAMMED SPACE PRESSURE SETPOINT (0.05" W.C. ADJ) THE RELIEF DAMPERS WILL BE INACTIVE. IF THE SPACE PRESSURE INCREASES ABOVE THE PROGRAMMED SPACE PRESSURE SETPOINT THE CONTROLLER WILL MODULATE THE RELIEF DAMPER TO RELIEVE BUILDING PRESSURE. WHEN THE SPACE PRESSURE DECREASES TO WITHIN THE PROGRAMMED SPACE PRESSURE SETPOINT, THE RELIEF DAMPER POSITION WILL REMAIN CONSTANT. WHEN THE SPACE PRESSURE EQUALS THE PROGRAMMED SPACE PRESSURE SETPOINT, THE CONTROLLER WILL MODULATE THE RELIEF AIR DAMPERS UNTIL BUILDING PRESSURE RETURNS TO THE PROGRAMMED SPACE PRESSURE SETPOINT. IF THE SPACE PRESSURE FALLS BELOW THE PROGRAMMED SPACE PRESSURE SETPOINT, THE CONTROLLER WILL DEACTIVATE THE RELIEF DAMPERS AND SET TO CLOSED POSITION. IF THE ECONOMIZER DAMPER CLOSES TO A POINT BELOW THE PROGRAMMED BUILDING PRESSURE ENABLED SETPOINT, THE CONTROLLER WILL ASSUME AN INACTIVE STATE. BUILDING PRESSURE SETPOINTS TO BE 0.05"-1.0" W.C. (ADJ).

IF SMOKE IS SENSED BY THE RETURN AIR SMOKE DETECTOR, THE UNIT WILL STOP AND THE OUTDOOR AIR DAMPER WILL CLOSE.

UNOCCUPIED CYCLE: THE UNIT FAN WILL REMAIN OFF AND THE OUTDOOR AIR DAMPER CLOSED. SHOULD THE SPACE TEMPERATURE AT ANY SENSOR IN THE ZONE FALL BELOW 55°F DURING THE UNOCCUPIED CYCLE, THE SUPPLY FAN AND HEATING WILL BE ENABLED. THE SYSTEM WILL REMAIN ON UNTIL ALL NIGHT TEMPERATURE SENSORS ARE SATISFIED.

NIGHT COOLING PURGE CYCLE: THE UNIT FAN WILL OPERATE ON FULL OUTDOOR AIR AND FULL RELIEF AIR UNDER THE FOLLOWING CONDITIONS:

1. THE SPACE TEMPERATURE IS GREATER THAN THE COOLING SET-UP TEMPERATURE.
2. THE OUTDOOR AIR TEMPERATURE IS 10°F COOLER THAN THE AVERAGE SPACE TEMPERATURE.
3. THE OUTDOOR AIR TEMPERATURE IS ABOVE 40°F.
4. OCCUPANCY IS LESS THAN SIX HOURS AWAY. THE PURGE CYCLE WILL AUTOMATICALLY ADJUST FOR A MANUAL OCCUPANCY OR OPTIMAL START CONDITION.

**SEQUENCE OF OPERATION**

**MULTI-ZONE AIR HANDLING UNITS - COLD AND HOT DECK**

THE UNIT(S) WILL BE CYCLED ON A TIME OF DAY SCHEDULE. THE UNIT START AND STOP TIMES WILL BE ADJUSTED BY THE OPTIMAL START/STOP PROGRAM.

OCCUPIED CYCLE: THE SUPPLY FAN AND RETURN FANS WILL RUN CONTINUOUSLY AND THE OUTDOOR AIR DAMPER WILL OPEN TO ITS MINIMUM POSITION.

THE COLD DECK TEMPERATURE SENSOR WILL MODULATE THE MIXED AIR DAMPERS ON THE CHILLED WATER VALVE IN SEQUENCE TO MAINTAIN THE COLD DECK TEMPERATURE SETPOINT. WHEN CHILLED WATER IS AVAILABLE FOR COOLING AND THE OUTDOOR ENTHALPY IS LESS THAN THE RETURN AIR ENTHALPY, THE OUTDOOR AIR DAMPERS WILL BE OPEN FULL. IF THE OUTDOOR AIR ENTHALPY IS GREATER THAN THE RETURN AIR ENTHALPY OF THE OUTDOOR AIR TEMPERATURE IS ABOVE 75°F, THE DAMPERS WILL BE IN THEIR MINIMUM POSITION. THE MIXED AIR DAMPERS WILL BE MODULATED TO LIMIT THE MIXED AIR TEMPERATURE FROM FALLING BELOW 55°F. SHOULD THE CHILLED WATER COIL ENTERING AIR TEMPERATURE DROP BELOW 45°F, AN ALARM WILL SOUND. IF THE MIXED AIR TEMPERATURE FALLS BELOW 40°F, THE UNIT SUPPLY AIR FAN WILL BE SHUTDOWN BY THE LOW LIMIT THERMOSTAT AND A MANUAL RESET OF LOW LIMIT THERMOSTAT WILL BE REQUIRED FOR THE UNIT SUPPLY FAN TO RESTART. THE RETURN AIR FAN WILL CONTINUE TO RUN.

THE RTU WILL MODULATE THE OUTPUT TO THE VFD AS REQUIRED TO MAINTAIN THE DUCT STATIC PRESSURE OF 1.5" W.C. IF THE DUCT STATIC PRESSURE FALLS BELOW 1.3" W.C. (ADJ) THE RTU WILL INCREASE THE OUTPUT TO THE VFD TO MAINTAIN SETPOINT. IF THE DUCT STATIC PRESSURE RISES ABOVE 1.7" W.C. THE RTU WILL DECREASE THE OUTPUT TO THE VFD TO MAINTAIN SETPOINT. RESET STATIC PRESSURE SETPOINT BASED ON THE ZONE REQUIRING THE MOST PRESSURE. THE SUPPLY DUCT STATIC PRESSURE SENSOR WILL ALSO ACT AS A HIGH DUCT STATIC PRESSURE SAFETY AND WILL SHUTDOWN THE TRU IN THE EVENT THAT THE DUCT STATIC PRESSURE REACHES 3.0" W.C. (ADJ). A RESET WILL BE REQUIRED TO RESET THE RTU. IF THE DUCT STATIC PRESSURE SENSOR FAILS, THEN THE VFD WILL MODULATE ITS SPEED TO 50%, AN ALARM WILL BE ANNUNCIATED.

IF THE SPACE PRESSURE IS EQUAL TO THE PROGRAMMED SPACE PRESSURE SETPOINT (0.05" W.C. ADJ) THE RELIEF DAMPERS WILL BE INACTIVE. IF THE SPACE PRESSURE INCREASES ABOVE THE PROGRAMMED SPACE PRESSURE SETPOINT THE CONTROLLER WILL MODULATE THE RELIEF DAMPER TO RELIEVE BUILDING PRESSURE. WHEN THE SPACE PRESSURE DECREASES TO WITHIN THE PROGRAMMED SPACE PRESSURE SETPOINT, THE RELIEF DAMPER POSITION WILL REMAIN CONSTANT. WHEN THE SPACE PRESSURE EQUALS THE PROGRAMMED SPACE PRESSURE SETPOINT, THE CONTROLLER WILL MODULATE THE RELIEF AIR DAMPERS UNTIL BUILDING PRESSURE RETURNS TO THE PROGRAMMED SPACE PRESSURE SETPOINT. IF THE SPACE PRESSURE FALLS BELOW THE PROGRAMMED SPACE PRESSURE SETPOINT, THE CONTROLLER WILL DEACTIVATE THE RELIEF DAMPERS AND SET TO CLOSED POSITION. IF THE ECONOMIZER DAMPER CLOSES TO A POINT BELOW THE PROGRAMMED BUILDING PRESSURE ENABLED SETPOINT, THE CONTROLLER WILL ASSUME AN INACTIVE STATE. BUILDING PRESSURE SETPOINTS TO BE 0.05"-1.0" W.C. (ADJ).

IF SMOKE IS SENSED BY THE RETURN AIR SMOKE DETECTOR, THE UNIT WILL STOP AND THE OUTDOOR AIR DAMPER WILL CLOSE.

UNOCCUPIED CYCLE: THE UNIT FAN WILL REMAIN OFF AND THE OUTDOOR AIR DAMPER CLOSED. SHOULD THE SPACE TEMPERATURE AT ANY SENSOR IN THE ZONE FALL BELOW 55°F DURING THE UNOCCUPIED CYCLE, THE SUPPLY FAN AND HEATING WILL BE ENABLED. THE SYSTEM WILL REMAIN ON UNTIL ALL NIGHT TEMPERATURE SENSORS ARE SATISFIED.

NIGHT COOLING PURGE CYCLE: THE UNIT FAN WILL OPERATE ON FULL OUTDOOR AIR AND FULL RELIEF AIR UNDER THE FOLLOWING CONDITIONS:

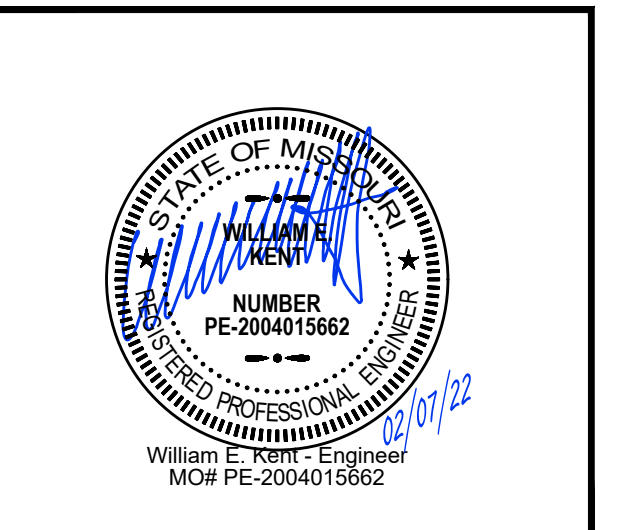
1. THE SPACE TEMPERATURE IS GREATER THAN THE COOLING SET-UP TEMPERATURE.
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3. THE OUTDOOR AIR TEMPERATURE IS ABOVE 40°F.
4. OCCUPANCY IS LESS THAN SIX HOURS AWAY. THE PURGE CYCLE WILL AUTOMATICALLY ADJUST FOR A MANUAL OCCUPANCY OR OPTIMAL START CONDITION.

**TEMPERATURE CONTROL SYMBOLS**

DO	DIGITAL OUTPUT	LS	LIMIT SWITCH
DI	DIGITAL INPUT	FS	FLOW SWITCH
AO	ANALOG OUTPUT	DP	DIFFERENTIAL PRESSURE SENSOR
AI	ANALOG INPUT	SP	STATIC PRESSURE SENSOR
LAT	LEAVING AIR TEMPERATURE	DATS	DISCHARGE AIR TEMPERATURE SENSOR
EAT	ENTERING AIR TEMPERATURE	MATS	MIXED AIR TEMPERATURE SENSOR
RA	RETURN AIR	CT	CURRENT TRANSDUCER
SA	SUPPLY AIR	STG	STAGE OF HEATING/COOLING
OA	OUTSIDE AIR	S/S	START / STOP
LWT	LEAVING WATER TEMPERATURE	DM	DAMPER MOTOR
EWT	ENTERING WATER TEMPERATURE	NC	NORMALLY CLOSED
CHW	CHILLED WATER	CO2	CARBON DIOXIDE
CWS	CHILLED WATER SUPPLY	VOC	VOLATILE ORGANIC COMPOUNDS
CWR	CHILLED WATER RETURN	DX	DIRECT EXPANSION
HW	HOT WATER	VFD	VARIABLE FREQUENCY DRIVE
HWS	HOT WATER SUPPLY	FAC	FIRE ALARM CONTROL PANEL
HWR	HOT WATER RETURN	CTRL	CONTROLLER
		AFMS	AIR FLOW MEASURING STATION

**KCK TEMPERATURE CONTROL REQUIREMENTS**

1. C&C GROUP IS THE APPROVED DDC CONTROL SYSTEM PROVIDER. ALL CONTROLS INSTALLED FOR THIS PROJECT SHALL BE OPEN PROTOCOL TO INTERFACE WITH LOW OR BACNET BASED SYSTEMS. NO PROPRIETARY SYSTEMS ALLOWED.
2. THE CENTRAL BAS SYSTEM LOCATED IN THE DISTRICT SHOP SHALL BE MODIFIED BY C&C GROUP TO ADD THESE CONTROLS AND POINTS. CONTRACTOR TO INCLUDE ALL PROGRAMMING NECESSARY.
3. TEMPERATURE SENSORS USED FOR THIS PROJECT SHALL NOT DISPLAY READOUTS.
4. PROVIDE TEMPERATURE MONITORING OF THE DATA ROOM CLOSETS. REPORT ALARMS ON HIGH (80°F ADJ) AND LOW (60°F ADJ) TEMPERATURES.
5. THE DDC SYSTEM SHALL PROVIDE DIAGNOSTIC CONTROL STEPS TO ALLOW KCK PERSONNEL TO TROUBLESHOOT THEIR SYSTEM. FOR RTU'S PROVIDE CONTROL TO COMMAND O.A. DAMPER OPEN/CLOSED, ENGAGE COMPRESSOR(S), ENGAGE HEAT AND START/STOP FAN.



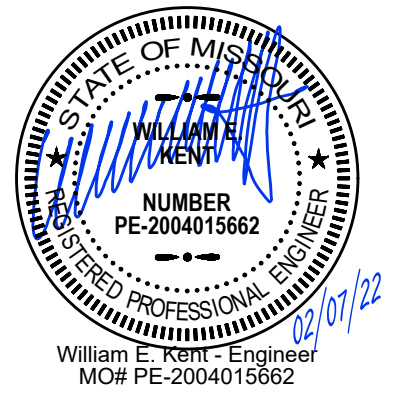
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ENGINEERS

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**KANSAS CITY KANSAS PUBLIC SCHOOLS  
MECHANICAL UPGRADES**

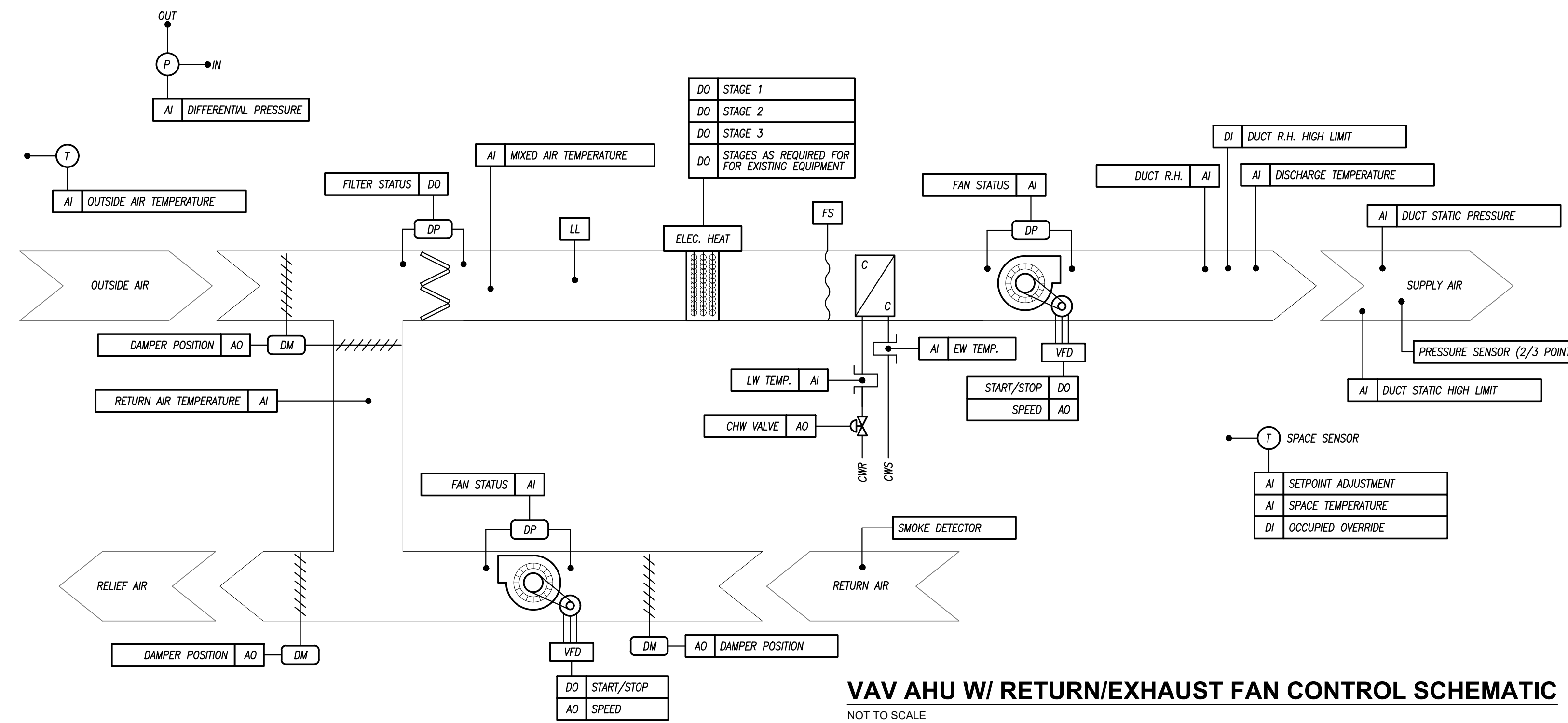
**EISENHOWER MIDDLE SCHOOL  
2901 N 72ND STREET  
KANSAS CITY, KANSAS 66109**

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MEP CONTROL SCHEMATICS	
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EMEP202	



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**VAV AHU W/ RETURN/EXHAUST FAN CONTROL SCHEMATIC**  
NOT TO SCALE

**SEQUENCE OF OPERATION**

**VAV AIR HANDLING UNITS - SINGLE DUCT**

THE UNIT(S) WILL BE CYCLED ON A TIME OF DAY SCHEDULE. THE UNIT START AND STOP TIMES WILL BE ADJUSTED BY THE OPTIMAL START/STOP PROGRAM.

OCCUPIED CYCLE: THE SUPPLY FAN AND RETURN FANS WILL RUN CONTINUOUSLY AND THE OUTDOOR AIR DAMPER WILL OPEN TO ITS MINIMUM POSITION.

THE COLD DECK TEMPERATURE SENSOR WILL MODULATE THE MIXED AIR DAMPERS ON THE CHILLED WATER VALVE IN SEQUENCE TO MAINTAIN THE COLD DECK TEMPERATURE SETPOINT. WHEN CHILLED WATER IS AVAILABLE FOR COOLING AND THE OUTDOOR ENTHALPY IS LESS THAN THE RETURN AIR ENTHALPY, THE OUTDOOR AIR DAMPERS WILL BE OPEN FULL. IF THE OUTDOOR AIR ENTHALPY IS GREATER THAN THE RETURN AIR ENTHALPY, THE OUTDOOR AIR TEMPERATURE IS ABOVE 75°F, THE DAMPERS WILL BE IN THEIR MINIMUM POSITION. THE MIXED AIR DAMPERS WILL BE MODULATED TO LIMIT THE MIXED AIR TEMPERATURE FROM FALLING BELOW 55°F. SHOULD THE CHILLED WATER COIL ENTERING AIR TEMPERATURE DROP BELOW 45°F, AN ALARM WILL SOUND. IF THE MIXED AIR TEMPERATURE FALLS BELOW 40°F, THE UNIT SUPPLY AIR FAN WILL BE SHUTDOWN BY THE LOW LIMIT THERMOSTAT AND A MANUAL RESET OF LOW LIMIT THERMOSTAT WILL BE REQUIRED FOR THE UNIT SUPPLY FAN TO RESTART. THE RETURN AIR FAN WILL CONTINUE TO RUN.

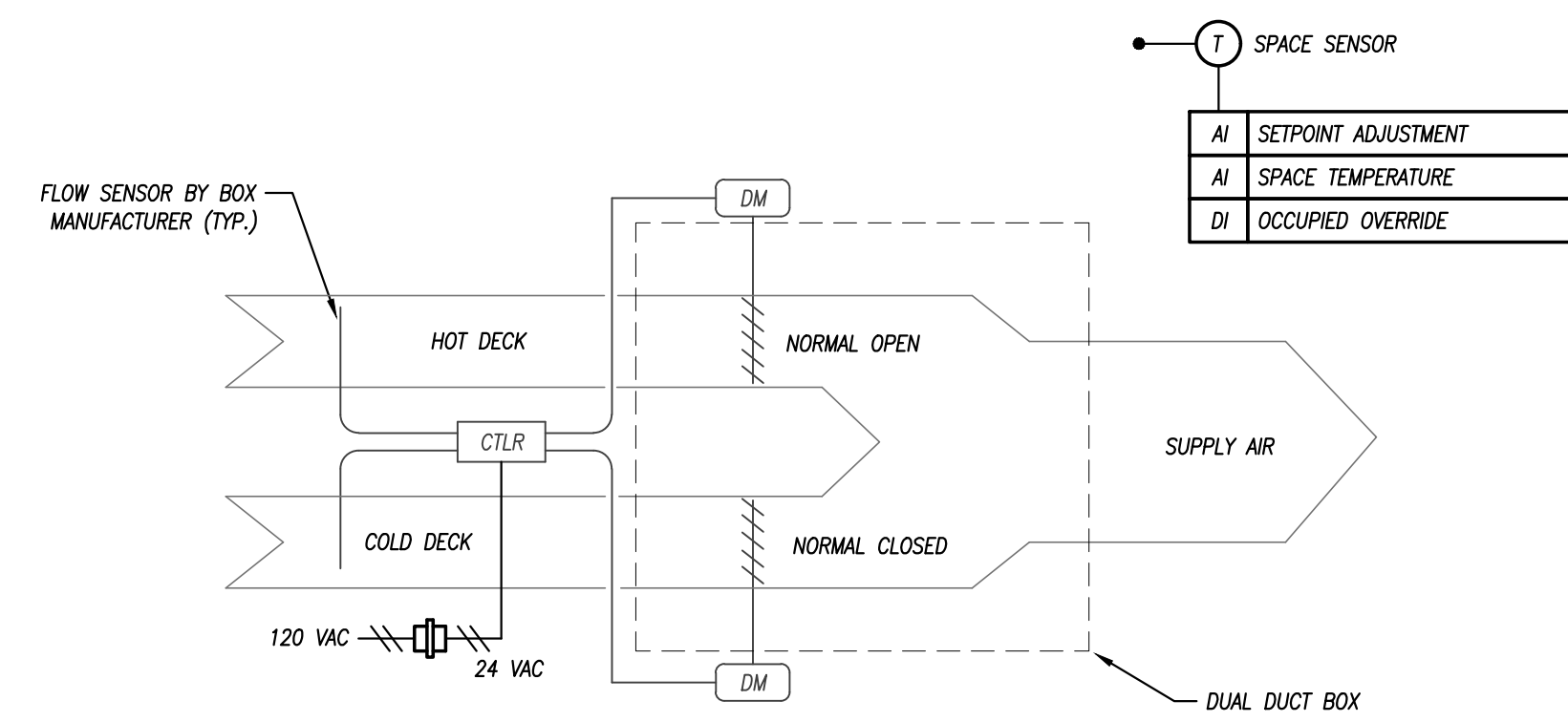
THE PREHEAT ELECTRIC HEATER (EDH), WILL BE ENABLED WHEN THE OUTDOOR AIR TEMPERATURE IS BELOW 55°F. THE EDH WILL BE CONTROLLED TO MAINTAIN A CONSTANT 55°F EDH DISCHARGE AIR TEMPERATURE. IF SMOKE IS SENSED BY THE RETURN AIR SMOKE DETECTOR, THE UNIT FANS WILL STOP THE OUTDOOR AND RELIEF AIR DAMPERS WILL CLOSE.

THE RTU WILL MODULATE THE OUTPUT TO THE VFD AS REQUIRED TO MAINTAIN THE DUCT STATIC PRESSURE OF 1.5" W.C. IF THE DUCT STATIC PRESSURE FALLS BELOW 1.3" W.C. (ADJ) THE RTU WILL INCREASE THE OUTPUT TO THE VFD TO MAINTAIN SETPOINT. IF THE DUCT STATIC PRESSURE RISES ABOVE 1.7" W.C. (ADJ) THE RTU WILL DECREASE THE OUTPUT TO THE VFD TO MAINTAIN SETPOINT. RESET STATIC PRESSURE SETPOINT BASED ON THE ZONE REQUIRING THE MOST PRESSURE. THE SUPPLY DUCT STATIC PRESSURE SENSOR WILL ALSO ACT AS A HIGH DUCT STATIC PRESSURE SAFETY AND WILL SHUTDOWN THE TRU IN THE EVENT THAT THE DUCT STATIC PRESSURE REACHES 3.0" W.C. (ADJ). A RESET WILL BE REQUIRED TO RESET THE RTU. IF THE DUCT STATIC PRESSURE SENSOR FAILS, THEN THE VFD WILL MODULATE ITS SPEED TO 50%, AN ALARM WILL BE ANNUNCIATED.

WHEN THE PROGRAMMED EXHAUST ENABLE SETPOINT IS REACHED, THE EXHAUST FAN CONTROL IS ACTIVATED. IF THE SPACE PRESSURE IS EQUAL TO THE PROGRAMMED SPACE PRESSURE SETPOINT THE EXHAUST FAN AND DAMPERS WILL BE INACTIVE. IF THE SPACE PRESSURE INCREASES ABOVE THE PROGRAMMED SPACE PRESSURE SETPOINT THE CONTROLLER WILL TURN ON THE EXHAUST FAN AND MODULATE THE EXHAUST FAN VFD/DAMPER TO RELIEVE BUILDING PRESSURE. WHEN THE SPACE PRESSURE DECREASES TO WITHIN THE PROGRAMMED SPACE PRESSURE SETPOINT, THE EXHAUST FAN VFD/DAMPER POSITION WILL REMAIN CONSTANT. WHEN THE SPACE PRESSURE EQUALS THE PROGRAMMED SPACE PRESSURE SETPOINT, THE CONTROLLER WILL MODULATE THE RELIEF AIR DAMPERS UNTIL BUILDING PRESSURE RETURNS TO THE PROGRAMMED SPACE PRESSURE SETPOINT. IF THE SPACE PRESSURE FALLS BELOW THE PROGRAMMED SPACE PRESSURE SETPOINT, THE CONTROLLER WILL DEACTIVATE THE EXHAUST FAN VFD/DAMPERS. IF THE ECONOMIZER DAMPER CLOSES TO A POINT BELOW THE PROGRAMMED EXHAUST ENABLED SETPOINT, THE CONTROLLER WILL ASSUME AN INACTIVE STATE.

IF SMOKE IS SENSED BY THE RETURN AIR SMOKE DETECTOR, THE UNIT WILL STOP AND THE OUTDOOR AIR DAMPER WILL CLOSE. UNOCCUPIED CYCLE: THE UNIT FAN WILL REMAIN OFF AND THE OUTDOOR AIR DAMPER CLOSED. SHOULD THE SPACE TEMPERATURE AT ANY SENSOR IN THE ZONE FALL BELOW 55°F DURING THE UNOCCUPIED CYCLE, THE SUPPLY FAN AND HEATING WILL BE ENABLED. THE SYSTEM WILL REMAIN ON UNTIL ALL NIGHT TEMPERATURE SENSORS ARE SATISFIED.

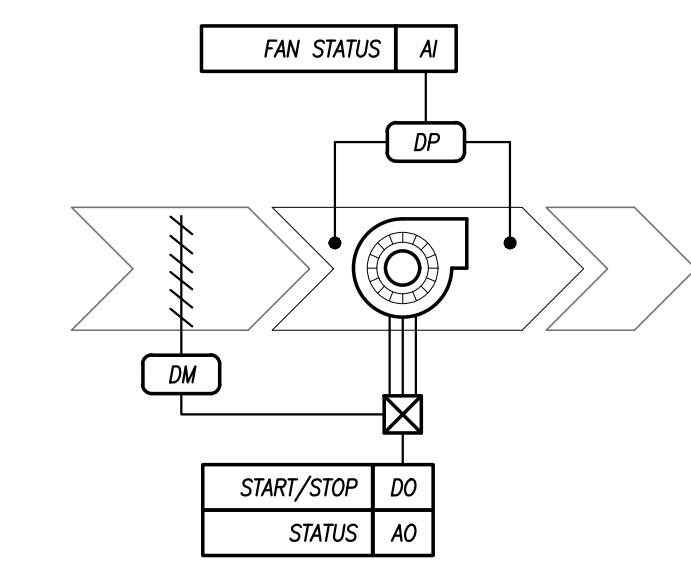
NIGHT COOLING PURGE CYCLE: THE UNIT FAN WILL OPERATE ON FULL OUTDOOR AIR AND FULL RELIEF AIR UNDER THE FOLLOWING CONDITIONS:  
1. THE SPACE TEMPERATURE IS GREATER THAN THE COOLING SET-UP TEMPERATURE.  
2. THE OUTDOOR AIR TEMPERATURE IS 10°F COOLER THAN THE AVERAGE SPACE TEMPERATURE.  
3. THE OUTDOOR AIR TEMPERATURE IS ABOVE 40°F.  
4. OCCUPANCY IS LESS THAN SIX HOURS AWAY. THE PURGE CYCLE WILL AUTOMATICALLY ADJUST FOR A MANUAL OCCUPANCY OR OPTIMAL START CONDITION.



**DUAL-DUCT BOX CONTROLS SCHEMATIC**  
NOT TO SCALE

**SEQUENCE OF OPERATION**

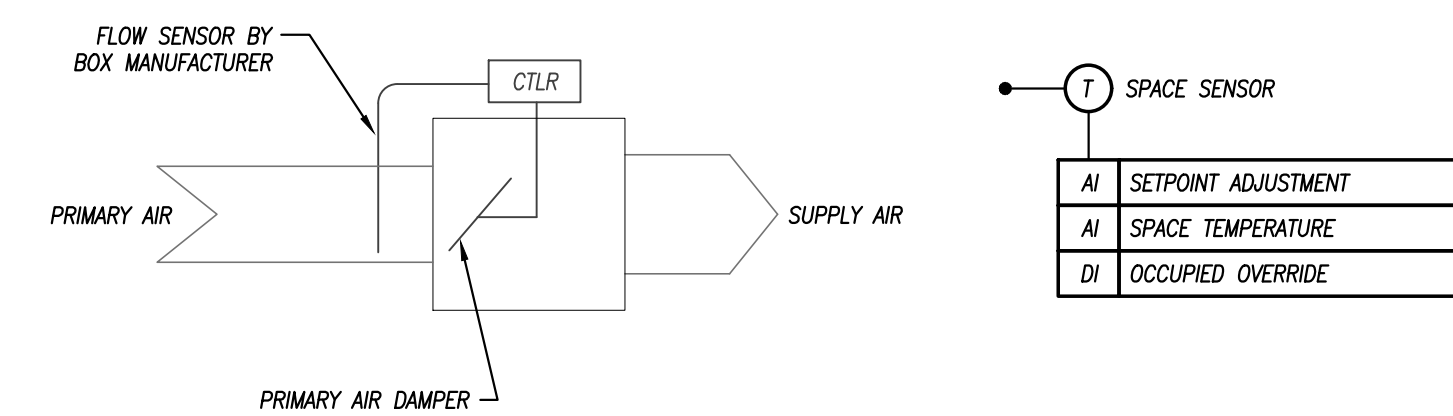
**DUAL-DUCT TERMINALS**  
THE OCCUPIED/UNOCCUPIED MODE OF OPERATION OF EACH TERMINAL SHALL BE DETERMINED BY THE TIMELOCK FUNCTION OF THE ENERGY MANAGEMENT SYSTEM. EACH TERMINAL/THERMOSTAT SHALL HAVE ITS OWN UNIQUE OCCUPIED/UNOCCUPIED SCHEDULE.  
DURING THE OCCUPIED MODE OF OPERATION, THE PRIMARY AIR DAMPER SHALL MODULATE TO MAINTAIN THE SELECTED SPACE OCCUPIED TEMPERATURE (ADJUSTABLE) AND SCHEDULED MINIMUM TERMINAL CFM.  
DURING THE UNOCCUPIED MODE OF OPERATION, IN COOLING MODE, AS TEMPERATURE APPROACHES, COLD AIR FLOW MODULATES FROM MAXIMUM TO MINIMUM MIXED AIR FLOW. AS TEMPERATURE CONTINUES TO DROP, WHEN THE HEATING MODE A FLOW RATE HIGHER THAN THE MINIMUM MIX IS EMPLOYED.



**EF CONTROLS SCHEMATIC**  
NOT TO SCALE

**SEQUENCE OF OPERATION**

**GENERAL VENTILATION**  
DDC SYSTEM SHALL STOP/START FAN BASED UPON OCCUPIED/UNOCCUPIED MODE. WHEN FAN IS RUNNING, EXHAUST DAMPER SHALL BE OPEN. WHEN FAN IS OFF, DAMPER SHALL BE CLOSED.



**VAV BOX CONTROL SCHEMATIC**  
NOT TO SCALE

**SEQUENCE OF OPERATION**

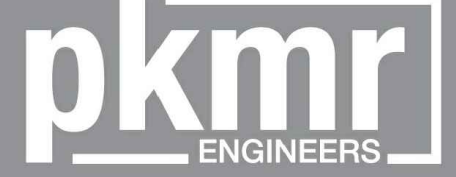
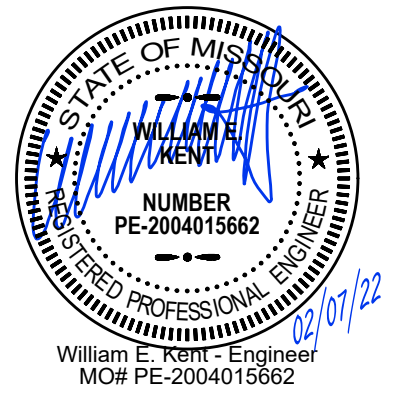
**VAV TERMINALS**  
THE OCCUPIED/UNOCCUPIED MODE OF OPERATION OF EACH TERMINAL SHALL BE DETERMINED BY THE TIMELOCK FUNCTION OF THE ENERGY MANAGEMENT SYSTEM. EACH TERMINAL/THERMOSTAT SHALL HAVE ITS OWN UNIQUE OCCUPIED/UNOCCUPIED SCHEDULE.  
DURING THE OCCUPIED MODE OF OPERATION, THE PRIMARY AIR DAMPER SHALL MODULATE TO MAINTAIN THE SELECTED SPACE OCCUPIED TEMPERATURE (ADJUSTABLE) AND SCHEDULED MINIMUM TERMINAL CFM.  
DURING THE UNOCCUPIED MODE OF OPERATION, THE PRIMARY AIR DAMPER SHALL BE CLOSED.  
THE LOCAL SPACE SENSOR SHALL HAVE AN OVERRIDE BUTTON TO ENERGIZE THE ASSOCIATED SYSTEM INTO THE OCCUPIED MODE. THIS BUTTON MAY BE DISABLED THROUGH THE EMS. THIS SPACE SENSOR SHALL ALLOW ADJUSTMENT OF THE SPACE SETPOINT 2 DEGREES (ADJUSTABLE) ABOVE OR BELOW THE SETPOINT ESTABLISHED IN THE EMS.

**KANSAS CITY KANSAS PUBLIC SCHOOLS  
MECHANICAL UPGRADES**  
EISENHOWER MIDDLE SCHOOL  
2901 N 72ND STREET  
KANSAS CITY, KANSAS 66109

ISSUED FOR:	
DESCRIPTION	DATE
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© PEARSON KENT MCKINLEY RAAF ENGINEERS, LLC	
DRAWN BY:	
CHECKED BY:	
SHEET TITLE: MEP CONTROL SCHEMATICS	
DATE: <b>02/07/22</b>	PKMR PROJECT: <b>21.659C</b>
SHEET NUMBER: <b>EMEP203</b>	







PEARSON KENT MCKINLEY RAAF ENGINEERS LLC  
 13300 W 98TH STREET  
 LENEXA, KS 66215  
 913.492.2400 WWW.PKMRENG.COM

**GENERAL HVAC NOTES**

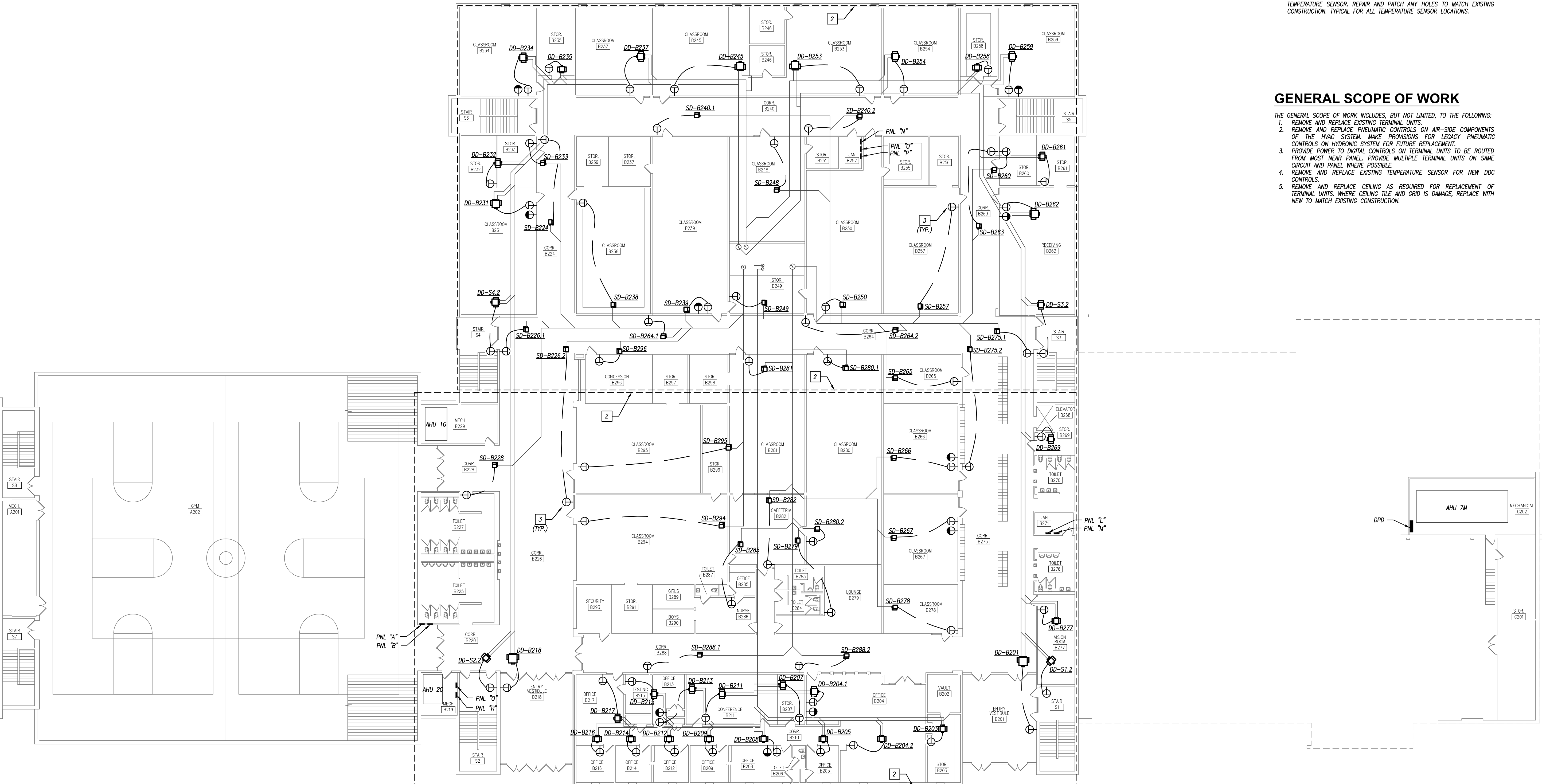
1. REFER TO GENERAL NOTES ON MEP COVER SHEET FOR ADDITIONAL REQUIREMENTS OF WORK.
2. ROUND BRANCH DUCT RUNOUTS AND FLEXIBLE DUCT SHALL BE THE SAME SIZE AS THE DIFFUSER NECK UNLESS NOTED OTHERWISE.
3. MAXIMUM FLEXIBLE DUCT LENGTH SHALL BE 5'-0".
4. ALL RUNOUTS TO TERMINAL BOXES SHALL BE ONE SIZE LARGER THAN BOX INLETS UNLESS NOTED OTHERWISE.
5. ALL AIR DISTRIBUTION DEVICES SHALL HAVE LOCKABLE VOLUME CONTROL DEVICES.
6. DUCT SIZES SHOWN ON PLANS ARE INSIDE FREE AREA.
7. FOR BALANCING THE OUTSIDE AIRFLOW QUANTITIES, REFER TO HVAC SCHEDULES.

**HVAC PLAN KEYED NOTES**

- \*NOT ALL KEYED NOTES ON USED ON EVERY SHEET.
- 1 EXISTING DAMPERS ON LOUVERS TO REMAIN. REPLACE ALL PNEUMATIC CONTROLS WITH DIGITAL CONTROLS. REFER TO CONTROLS SCHEMATICS.
  - 2 ROUTE ELECTRICAL POWER CONNECTIONS TO TERMINAL UNIT CONTROLS TO MOST NEAR PANEL. CONTRACTOR SHALL CONFIRM PANEL CAPACITIES AND OPEN BREAKER SPACES.
  - 3 REPLACE EXISTING TEMPERATURE SENSOR TO COMMUNICATE WITH BUILDING CONTROLS. USE EXISTING TEMPERATURE SENSOR LOCATION FOR NEW TEMPERATURE SENSOR. REPAIR AND PATCH ANY HOLES TO MATCH EXISTING CONSTRUCTION. TYPICAL FOR ALL TEMPERATURE SENSOR LOCATIONS.

**GENERAL SCOPE OF WORK**

- THE GENERAL SCOPE OF WORK INCLUDES, BUT NOT LIMITED, TO THE FOLLOWING:
1. REMOVE AND REPLACE EXISTING TERMINAL UNITS.
  2. REMOVE AND REPLACE PNEUMATIC CONTROLS ON AIR-SIDE COMPONENTS OF THE HVAC SYSTEM. MAKE PROVISIONS FOR LEGACY PNEUMATIC CONTROLS ON HYDRONIC SYSTEM FOR FUTURE REPLACEMENT.
  3. PROVIDE POWER TO DIGITAL CONTROLS ON TERMINAL UNITS TO BE ROUTED FROM MOST NEAR PANEL. PROVIDE MULTIPLE TERMINAL UNITS ON SAME CIRCUIT AND PANEL WHERE POSSIBLE.
  4. REMOVE AND REPLACE EXISTING TEMPERATURE SENSOR FOR NEW DDC CONTROLS.
  5. REMOVE AND REPLACE CEILING AS REQUIRED FOR REPLACEMENT OF TERMINAL UNITS. WHERE CEILING TILE AND GRID IS DAMAGE, REPLACE WITH NEW TO MATCH EXISTING CONSTRUCTION.



**MEP MIDDLE LEVEL PLAN**  
 1/16" = 1'-0"

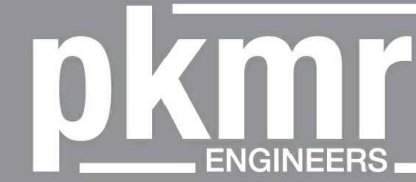
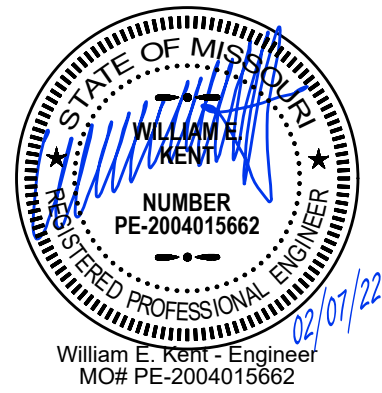
**KANSAS CITY KANSAS PUBLIC SCHOOLS**  
**SCHLAGLE HIGH SCHOOL**  
**MECHANICAL UPGRADES**  
 2214 N 59 ST  
 KANSAS CITY, KANSAS 66104

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SHEET TITLE:  
 MEP MIDDLE LEVEL

DATE: 02/07/22 PKMR PROJECT: 21.659C  
 SHEET NUMBER:



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 913.492.2400 WWW.PKMRENG.COM

**GENERAL HVAC NOTES**

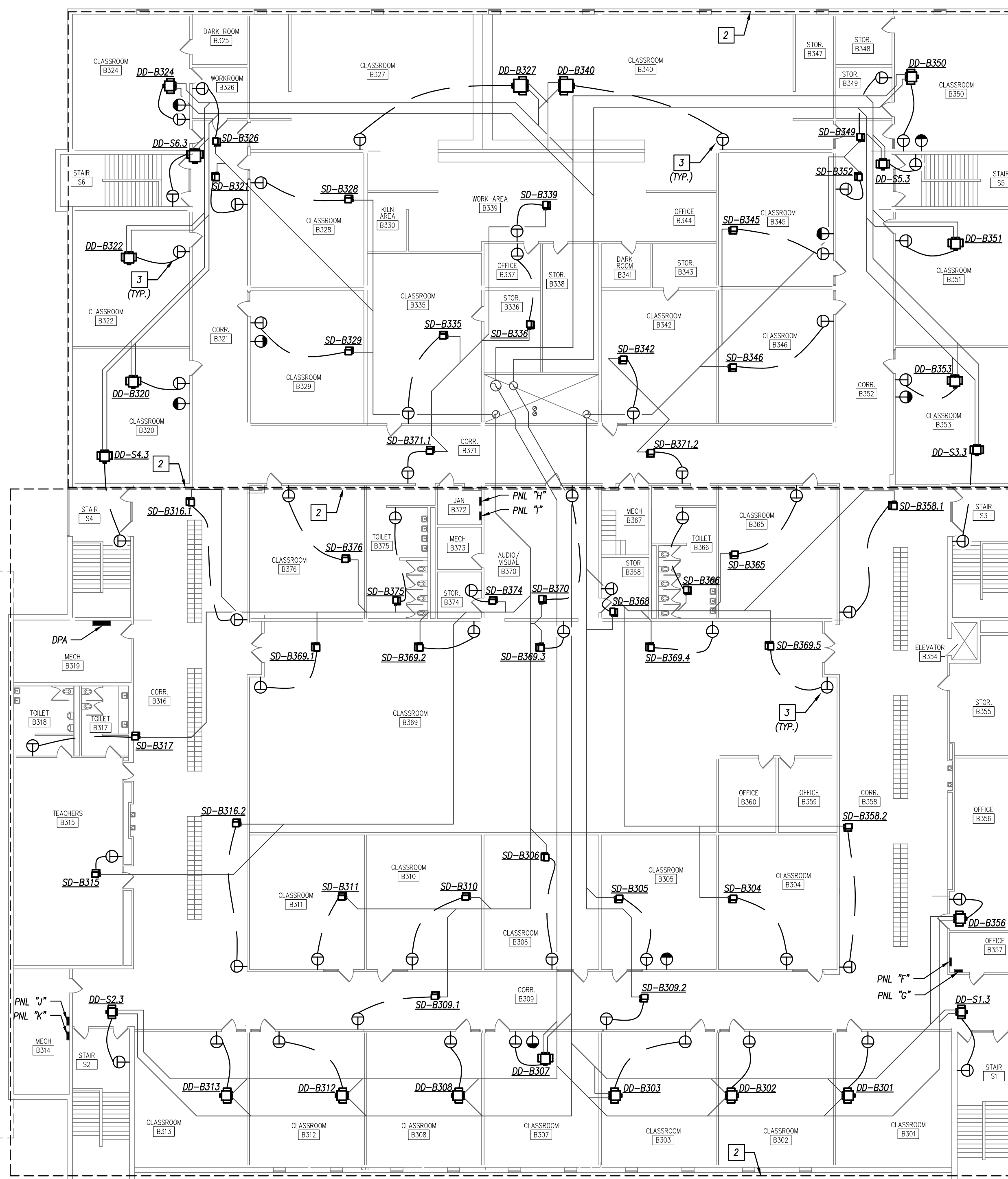
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**GENERAL SCOPE OF WORK**

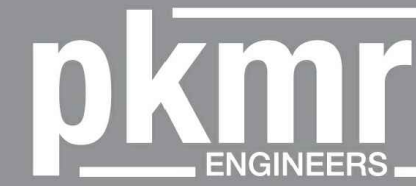
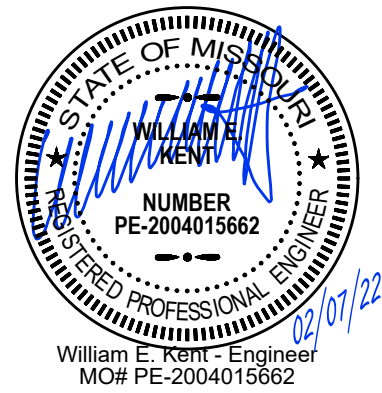
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**MEP UPPER LEVEL PLAN**  
 1/16" = 1'-0"

**KANSAS CITY KANSAS PUBLIC SCHOOLS**  
**SCHLAGLE HIGH SCHOOL**  
**MECHANICAL UPGRADES**  
 2214 N 59 ST  
 KANSAS CITY, KANSAS 66104

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SHEET TITLE:	
MEP UPPER LEVEL	
DATE:	PKMR PROJECT:
02/07/22	21.659C
SHEET NUMBER:	
SMEP103	
Page 98 of 101	



PEARSON KENT MCKINLEY RAAF ENGINEERS LLC  
 13300 W 98TH STREET LEXENGA, KS 66215  
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**GENERAL HVAC NOTES**

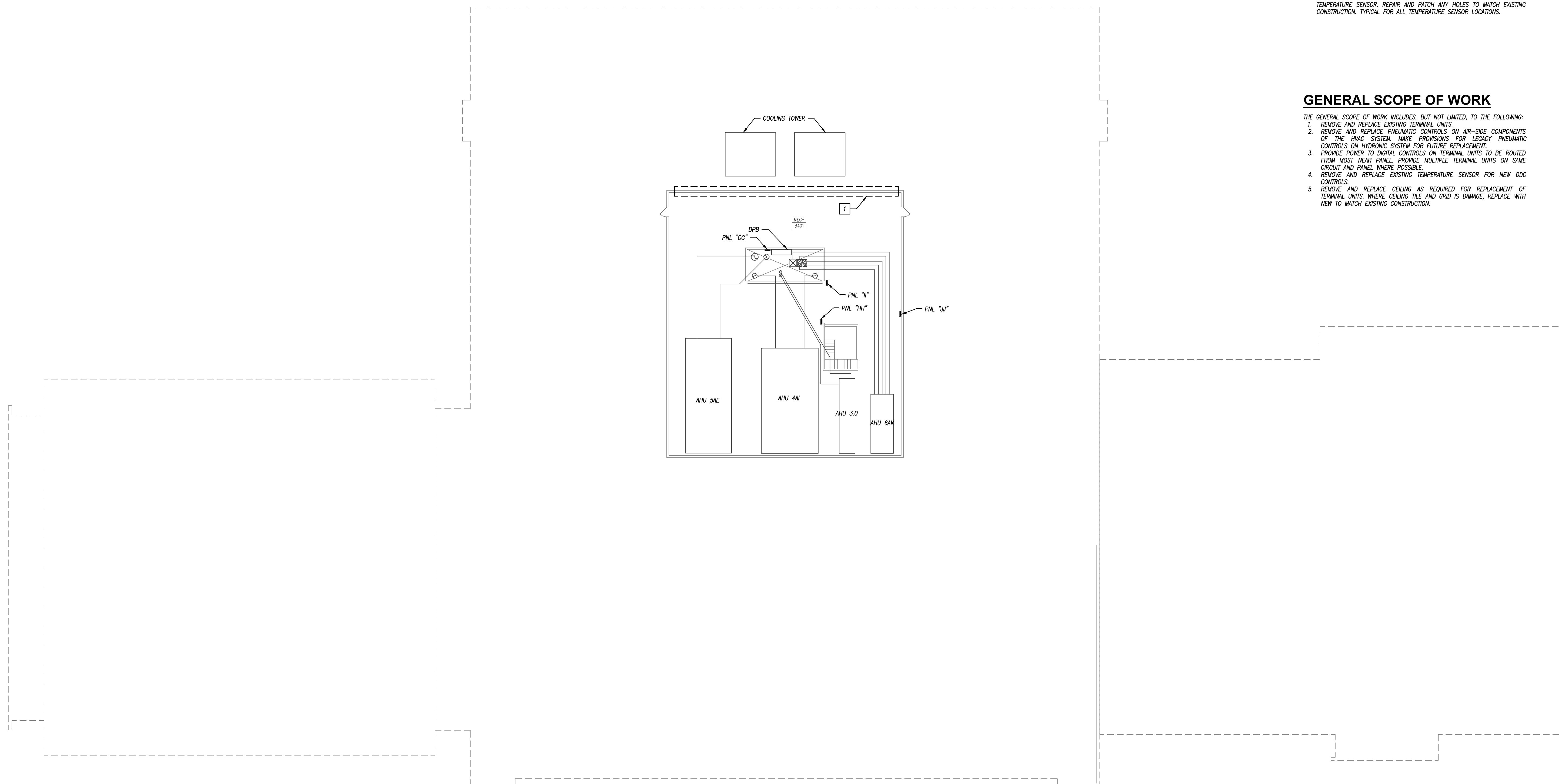
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**MEP PENTHOUSE LEVEL PLAN**  
 1/16" = 1'-0"

**KANSAS CITY KANSAS PUBLIC SCHOOLS**  
**SCHLAGLE HIGH SCHOOL**  
**MECHANICAL UPGRADES**  
 2214 N 59 ST  
 KANSAS CITY, KANSAS 66104

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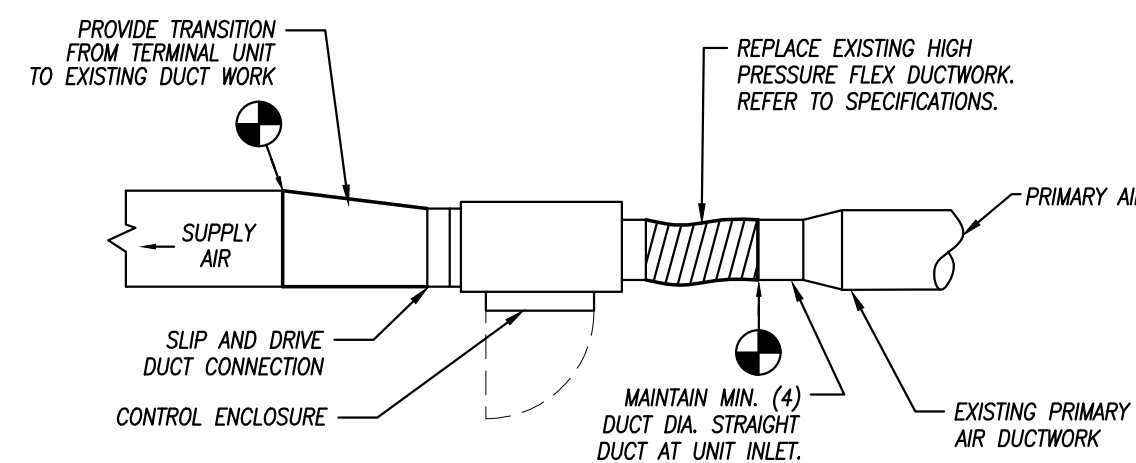
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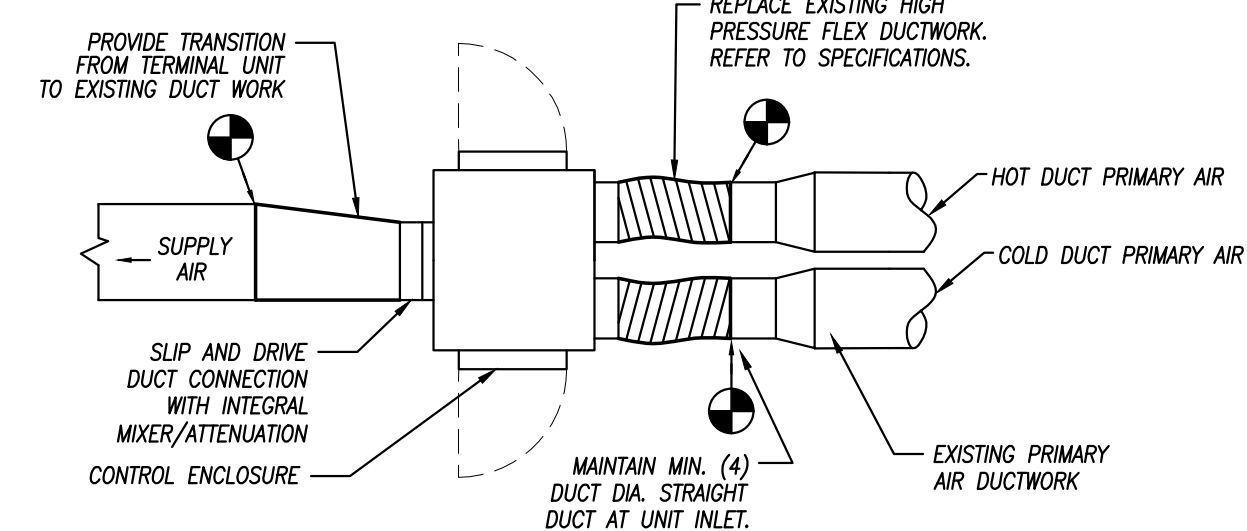
SHEET TITLE:  
 MEP PENTHOUSE LEVEL

DATE: <b>02/07/22</b>	PKMR PROJECT: <b>21.659C</b>
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SHEET NUMBER:  
**SMEP104**  
 Page 99 of 101



**VAV TERMINAL BOX DETAIL**  
NOT TO SCALE



**DUAL-DUCT TERMINAL BOX DETAIL**  
NOT TO SCALE

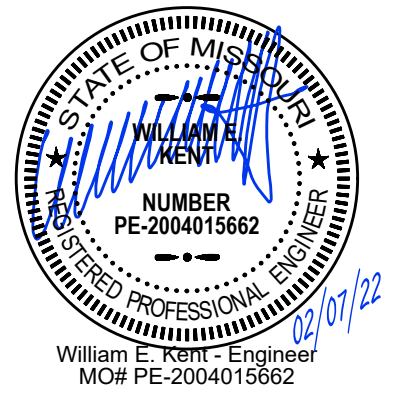
**SINGLE DUCT BOX SCHEDULE**

PLAN MARK	AHU SERVED	ROOM NUMBER	MANUFACTURER	MODEL NUMBER	INLET SIZE	CFM COOLING	MINIMUM CFM	REMARKS
SD-A115	AHU-4M	A115	TITUS	DESV	14"	2,475	371	ALL
SD-B108	AHU-4M	B108	TITUS	DESV	10"	1,200	180	ALL
SD-B109	AHU-4M	B106,107,109	TITUS	DESV	8"	600	90	ALL
SD-B113	AHU-4M	B113	TITUS	DESV	4"	225	34	ALL
SD-B115	AHU-4M	B115	TITUS	DESV	7"	400	60	ALL
SD-B117	AHU-4M	B117	TITUS	DESV	12"	1,230	185	ALL
SD-B119	AHU-4M	B119	TITUS	DESV	8"	800	120	ALL
SD-B120	AHU-4M	B118,120	TITUS	DESV	6"	300	45	ALL
SD-B122	AHU-4M	B122,123,124	TITUS	DESV	7"	400	60	ALL
SD-B127	AHU-4M	B127	TITUS	DESV	8"	600	90	ALL
SD-B132.1	AHU-4M	B132	TITUS	DESV	12"	1,635	245	ALL
SD-B132.2	AHU-4M	B132	TITUS	DESV	12"	1,635	245	ALL
SD-B132.3	AHU-4M	B132	TITUS	DESV	12"	1,635	245	ALL
SD-B132.4	AHU-4M	B132	TITUS	DESV	12"	1,635	245	ALL
SD-B132.5	AHU-4M	B132	TITUS	DESV	12"	1,635	245	ALL
SD-B136	AHU-4M	B134,136,137	TITUS	DESV	4"	205	31	ALL
SD-B141	AHU-4M	B141	TITUS	DESV	6"	410	62	ALL
SD-B143	AHU-4M	B143	TITUS	DESV	10"	1,200	180	ALL
SD-B145	AHU-4M	B142,144,145	TITUS	DESV	8"	600	90	ALL
SD-B160	AHU-4M	B160	TITUS	DESV	4"	120	18	ALL
SD-B167	AHU-4M	B167	TITUS	DESV	4"	300	45	ALL
SD-B168	AHU-4M	B168	TITUS	DESV	6"	450	68	ALL
SD-B169	AHU-4M	B162,169	TITUS	DESV	9"	950	143	ALL
SD-B224	AHU-4M	B224	TITUS	DESV	4"	140	21	ALL
SD-B226.1	AHU-4M	B226	TITUS	DESV	8"	650	98	ALL
SD-B226.2	AHU-4M	B226	TITUS	DESV	8"	670	101	ALL
SD-B228	AHU-4M	B220,225,227,228	TITUS	DESV	10"	1,000	150	ALL
SD-B233	AHU-4M	B233	TITUS	DESV	4"	160	24	ALL
SD-B238	AHU-4M	B236,238	TITUS	DESV	10"	1,200	180	ALL
SD-B239	AHU-4M	B237,239	TITUS	DESV	14"	2,800	420	ALL
SD-B240.1	AHU-4M	B240	TITUS	DESV	4"	140	21	ALL
SD-B240.2	AHU-4M	B240	TITUS	DESV	4"	140	21	ALL
SD-B248	AHU-4M	B246,248,251,252	TITUS	DESV	12"	1,360	204	ALL
SD-B249	AHU-4M	B249	TITUS	DESV	4"	120	18	ALL
SD-B250	AHU-4M	B250,255	TITUS	DESV	14"	2,200	330	ALL
SD-B257	AHU-4M	B256,257	TITUS	DESV	10"	1,200	180	ALL
SD-B260	AHU-4M	B260	TITUS	DESV	4"	160	24	ALL
SD-B263	AHU-4M	B263	TITUS	DESV	4"	140	21	ALL
SD-B264.1	AHU-4M	B264	TITUS	DESV	4"	140	21	ALL
SD-B264.2	AHU-4M	B264	TITUS	DESV	4"	140	21	ALL
SD-B265	AHU-4M	B265	TITUS	DESV	4"	300	45	ALL
SD-B266	AHU-4M	B266	TITUS	DESV	6"	520	78	ALL
SD-B267	AHU-4M	B267	TITUS	DESV	6"	520	78	ALL
SD-B275.1	AHU-4M	B275	TITUS	DESV	8"	650	98	ALL
SD-B275.2	AHU-4M	B275	TITUS	DESV	8"	670	101	ALL
SD-B278	AHU-4M	B278	TITUS	DESV	4"	280	42	ALL
SD-B279	AHU-4M	B279,283,284	TITUS	DESV	8"	560	84	ALL
SD-B280.1	AHU-4M	B280	TITUS	DESV	12"	1,560	234	ALL
SD-B280.2	AHU-4M	B280	TITUS	DESV	6"	360	54	ALL
SD-B281	AHU-4M	B281	TITUS	DESV	12"	1,320	198	ALL
SD-B282	AHU-4M	B282	TITUS	DESV	6"	550	83	ALL
SD-B285	AHU-4M	B285,286,288,290,291,293	TITUS	DESV	9"	860	129	ALL
SD-B288.1	AHU-4M	B288	TITUS	DESV	4"	140	21	ALL
SD-B288.2	AHU-4M	B288	TITUS	DESV	4"	140	21	ALL
SD-B294	AHU-4M	B294	TITUS	DESV	12"	1,650	248	ALL
SD-B295	AHU-4M	B295,297,298,299	TITUS	DESV	14"	2,190	329	ALL
SD-B296	AHU-4M	B296	TITUS	DESV	5"	450	68	ALL
SD-B304	AHU-4M	B304	TITUS	DESV	9"	750	113	ALL
SD-B305	AHU-4M	B305	TITUS	DESV	9"	750	113	ALL
SD-B306	AHU-4M	B306	TITUS	DESV	9"	750	113	ALL
SD-B309.1	AHU-4M	B309	TITUS	DESV	4"	200	30	ALL
SD-B309.2	AHU-4M	B309	TITUS	DESV	4"	200	30	ALL
SD-B310.1	AHU-4M	B310	TITUS	DESV	9"	750	113	ALL
SD-B311	AHU-4M	B311	TITUS	DESV	9"	750	113	ALL
SD-B315	AHU-4M	B315	TITUS	DESV	12"	1,500	225	ALL
SD-B316.1	AHU-4M	B316	TITUS	DESV	10"	1,300	195	ALL
SD-B316.2	AHU-4M	B316	TITUS	DESV	8"	600	90	ALL
SD-B317	AHU-4M	B317,318	TITUS	DESV	6"	350	53	ALL
SD-B321	AHU-4M	B321	TITUS	DESV	7"	500	75	ALL
SD-B326	AHU-4M	B326	TITUS	DESV	7"	425	64	ALL
SD-B328	AHU-4M	B328	TITUS	DESV	9"	750	113	ALL
SD-B329	AHU-4M	B329	TITUS	DESV	9"	750	113	ALL
SD-B335	AHU-4M	B335	TITUS	DESV	12"	1,250	188	ALL
SD-B336	AHU-4M	B336,337,338,341,343	TITUS	DESV	9"	730	110	ALL
SD-B339	AHU-4M	B330,339,340	TITUS	DESV	12"	1,885	283	ALL
SD-B342	AHU-4M	B342	TITUS	DESV	9"	750	113	ALL
SD-B345	AHU-4M	B345	TITUS	DESV	12"	1,300	195	ALL
SD-B346	AHU-4M	B346	TITUS	DESV	6"	600	90	ALL
SD-B349	AHU-4M	B349	TITUS	DESV	4"	120	18	ALL
SD-B352	AHU-4M	B352	TITUS	DESV	7"	500	75	ALL
SD-B358.1	AHU-4M	B358	TITUS	DESV	10"	1,300	195	ALL
SD-B358.2	AHU-4M	B358	TITUS	DESV	8"	600	90	ALL
SD-B365	AHU-4M	B365	TITUS	DESV	9"	750	113	ALL
SD-B366	AHU-4M	B366	TITUS	DESV	4"	200	30	ALL
SD-B368	AHU-4M	B368	TITUS	DESV	4"	100	15	ALL
SD-B369.1	AHU-4M	B369	TITUS	DESV	10"	850	128	ALL
SD-B369.2	AHU-4M	B369	TITUS	DESV	10"	850	128	ALL
SD-B369.3	AHU-4M	B369	TITUS	DESV	10"	850	128	ALL
SD-B369.4	AHU-4M	B369	TITUS	DESV	10"	850	128	ALL
SD-B369.5	AHU-4M	B359,360,369	TITUS	DESV	10"	850	128	ALL
SD-B370	AHU-4M	B370	TITUS	DESV	8"	700	105	ALL
SD-B371.1	AHU-4M	B371	TITUS	DESV	4"	200	30	ALL
SD-B371.2	AHU-4M	B371	TITUS	DESV	4"	200	30	ALL
SD-B374	AHU-4M	B374	TITUS	DESV	4"	100	15	ALL
SD-B375	AHU-4M	B375	TITUS	DESV	4"	200	30	ALL
SD-B376	AHU-4M	B376	TITUS	DESV	9"	750	113	ALL

**REMARKS:**  
 1. INSTALL HIGH PRESSURE FLEXIBLE DUCT CONNECTOR AT INLET. REFER TO SPECIFICATIONS.  
 2. PROVIDE FACTORY INSTALLED CONTROL POWER TRANSFORMER (120-277V/50A)+UNIT CONTROLLER.  
 3. PROVIDE PRESSURE INDEPENDENT, DDC CONTROL PACKAGE.  
 4. PROVIDE TERMINAL UNITS WITH INTEGRAL SOUND ATTENUATOR.  
 5. PROVIDE UNITS SIZE EQUAL TO OR LESS THAN 80% OF MANUFACTURER'S MAXIMUM AIR FLOW.

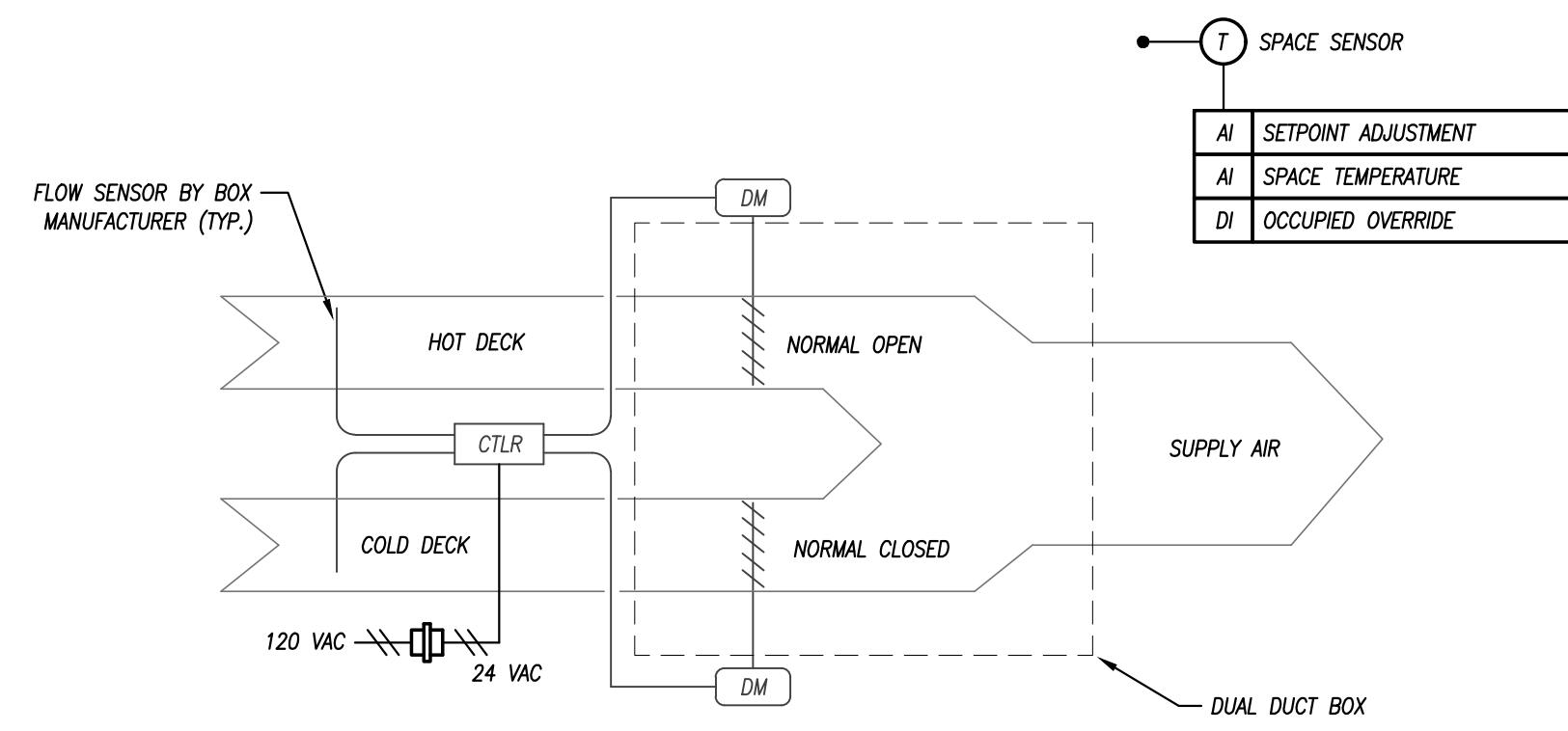
**DUAL DUCT BOX SCHEDULE**

PLAN MARK	AHU SERVED	ROOM NUMBER	MANUFACTURER	MODEL NUMBER	INLET SIZE		PRIMARY CFM		MINIMUM CFM	REMARKS
					COLD	HOT	COLD	HOT		
DD-S1.1	AHU-SAE	S1	TITUS	DEDV	5"	5"	200	150	30	ALL
DD-S2.1	AHU-SAE	S2	TITUS	DEDV	5"	5"	200	150	30	ALL
DD-S3.1	AHU-SAE	S3	TITUS	DEDV	5"	5"	300	225	45	ALL
DD-S4.1	AHU-SAE	S4	TITUS	DEDV	8"	8"	550	413	83	ALL
DD-S5.1	AHU-SAE	S5	TITUS	DEDV	6"	6"	400	300	60	ALL
DD-S6.1	AHU-SAE	S6	TITUS	DEDV	8"	8"	450	338	68	ALL
DD-B101	AHU-SAE	B101	TITUS	DEDV	8"	8"	700	525	105	ALL
DD-B112	AHU-SAE	B112	TITUS	DEDV	6"	6"	250	188	38	ALL
DD-B114	AHU-SAE	B114	TITUS	DEDV	12"	12"	1,500	1,125	225	ALL
DD-B116	AHU-SAE	B116	TITUS	DEDV	8"	8"	845	634	127	ALL
DD-B117	AHU-SAE	B117, B161	TITUS	DEDV	14"	14"	3,040	2,280	456	ALL
DD-B133	AHU-SAE	B133	TITUS	DEDV	14"	14"	2,720	2,040	408	ALL
DD-B135	AHU-SAE	B135	TITUS	DEDV	8"	8"	800	600	120	ALL
DD-B138	AHU-SAE	B138	TITUS	DEDV	14"	14"	2,200	1,650	330	ALL
DD-B140	AHU-SAE	B140	TITUS	DEDV	8"	8"	700	525	105	ALL
DD-B162	AHU-SAE	B162	TITUS	DEDV	14"	14"	3,040	2,280	456	ALL
DD-B163	AHU-SAE	B163	TITUS	DEDV	10"	10"	1,000	750	150	ALL
DD-C101.1	AHU-7M	C101	TITUS	DEDV	14"	14"	2,280	1,710	342	ALL
DD-C101.2	AHU-7M	C101	TITUS	DEDV	16"	16"	2,850	2,138	428	ALL
DD-C101.3	AHU-7M	C101	TITUS	DEDV	14"	14"	1,925	1,444	289	ALL
DD-C101.4	AHU-7M	C101	TITUS	DEDV	12"	12"	1,540	1,155	231	ALL
DD-C101.5	AHU-7M	C101	TITUS	DEDV	12"	12"	1,280	960	192	ALL
DD-C101.6	AHU-7M	C101	TITUS	DEDV	12"	12"	1,600	1,200	240	ALL
DD-C103.1	AHU-7M	C103	TITUS	DEDV	14"	14"	3,200	2,400	480	ALL
DD-C103.2	AHU-7M	C103	TITUS	DEDV	14"	14"	3,200	2,400	480	ALL
DD-C103.3	AHU-7M	C103	TITUS	DEDV	14"	14"	2,400	1,800	360	ALL
DD-C106	AHU-7M	C104,105,106	TITUS	DEDV	6"	6"	440	330	66	ALL
DD-C109	AHU-7M	C109,110,111	TITUS	DEDV	6"	6"	420	315	63	ALL
DD-C113	AHU-7M	C112,113	TITUS	DEDV	5"	5"	300	225	45	ALL
DD-C114	AHU-7M	C114,107	TITUS	DEDV	6"	6"	400	300	60	ALL
DD-C115	AHU-7M	C115	TITUS	DEDV	16"	16"	3,510	2,633	527	ALL
DD-C116	AHU-7M	C116	TITUS	DEDV	5"	5"	275	206	41	ALL
DD-C118	AHU-7M	C117,118,121,122,123	TITUS	DEDV	7"	7"	460	345	69	ALL
DD-C120	AHU-7M	C120	TITUS	DEDV	14"	14"	2,720	2,040	408	ALL
DD-C124	AHU-7M	C124	TITUS	DEDV	10"	10"	1,200	900	180	ALL
DD-S1.2	AHU-SAE	S1	TITUS	DEDV	5"	5"	250	188	38	ALL
DD-S2.2	AHU-SAE	S2	TITUS	DEDV	5"	5"	200	150	30	ALL
DD-S3.2	AHU-SAE	S3	TITUS	DEDV	5"	5"	270	203	41	ALL
DD-S4.2	AHU-SAE	S4	TITUS	DEDV	8"	8"	510	383	77	ALL
DD-B201	AHU-30	B201	TITUS	DEDV	12"	12"	1,080	810	162	ALL
DD-B203	AHU-30	B203	TITUS	DEDV	5"	5"	260	195	39	ALL
DD-B204.1	AHU-30	B204	TITUS	DEDV	9"	9"	850	638	128	ALL
DD-B204.2	AHU-30	B204	TITUS	DEDV	6"	6"	500	375	75	ALL
DD-B205	AHU-30	B205	TITUS	DEDV	5"	5"	255	191	38	ALL
DD-B207	AHU-30	B207	TITUS	DEDV	4"	4"	120	90	18	ALL
DD-B										



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**DUAL-DUCT BOX CONTROLS SCHEMATIC**

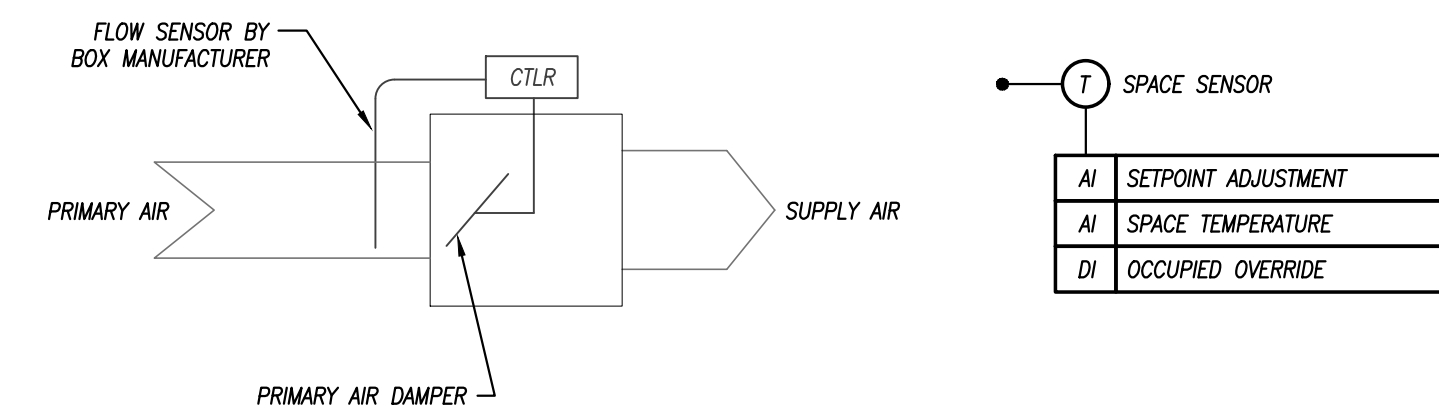
NOT TO SCALE

**DUAL-DUCT TERMINALS**

THE OCCUPIED/UNOCCUPIED MODE OF OPERATION OF EACH TERMINAL SHALL BE DETERMINED BY THE TIMELOCK FUNCTION OF THE ENERGY MANAGEMENT SYSTEM. EACH TERMINAL/THERMOSTAT SHALL HAVE ITS OWN UNIQUE OCCUPIED/UNOCCUPIED SCHEDULE.

DURING THE OCCUPIED MODE OF OPERATION, THE PRIMARY AIR DAMPER SHALL MODULATE TO MAINTAIN THE SELECTED SPACE OCCUPIED TEMPERATURE (ADJUSTABLE) AND SCHEDULED MINIMUM TERMINAL CFM.

DURING THE UNOCCUPIED MODE OF OPERATION, IN COOLING MODE, AS TEMPERATURE APPROACHES, COLD AIR FLOW MODULATES FROM MAXIMUM TO MINIMUM MIXED AIR FLOW. AS TEMPERATURE CONTINUES TO DROP, WHEN THE HEATING MODE A FLOW RATE HIGHER THAN THE MINIMUM MIX IS EMPLOYED.



**VAV BOX CONTROL SCHEMATIC**

NOT TO SCALE

**SEQUENCE OF OPERATION**

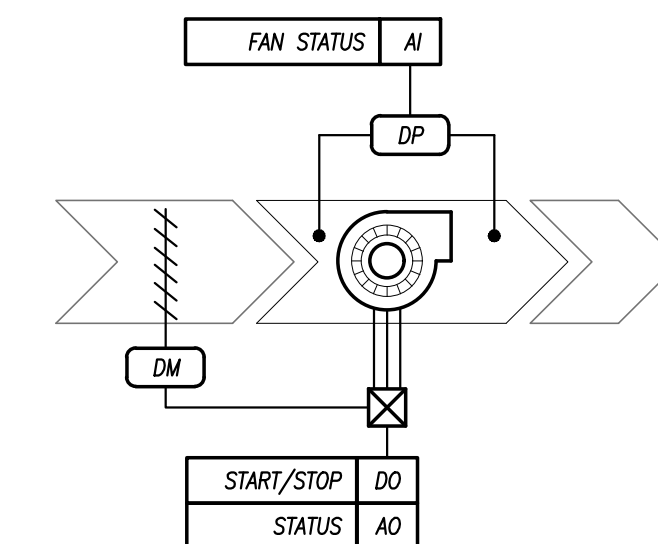
**VAV TERMINALS**

THE OCCUPIED/UNOCCUPIED MODE OF OPERATION OF EACH TERMINAL SHALL BE DETERMINED BY THE TIMELOCK FUNCTION OF THE ENERGY MANAGEMENT SYSTEM. EACH TERMINAL/THERMOSTAT SHALL HAVE ITS OWN UNIQUE OCCUPIED/UNOCCUPIED SCHEDULE.

DURING THE OCCUPIED MODE OF OPERATION, THE PRIMARY AIR DAMPER SHALL MODULATE TO MAINTAIN THE SELECTED SPACE OCCUPIED TEMPERATURE (ADJUSTABLE) AND SCHEDULED MINIMUM TERMINAL CFM.

DURING THE UNOCCUPIED MODE OF OPERATION, THE PRIMARY AIR DAMPER SHALL BE CLOSED.

THE LOCAL SPACE SENSOR SHALL HAVE AN OVERRIDE BUTTON TO ENERGIZE THE ASSOCIATED SYSTEM INTO THE OCCUPIED MODE. THIS BUTTON MAY BE DISABLED THROUGH THE EMS. THIS SPACE SENSOR SHALL ALLOW ADJUSTMENT OF THE SPACE SETPOINT 2 DEGREES (ADJUSTABLE) ABOVE OR BELOW THE SETPOINT ESTABLISHED IN THE EMS.



**EF CONTROLS SCHEMATIC**

NOT TO SCALE

**SEQUENCE OF OPERATION**

**GENERAL VENTILATION**

DDC SYSTEM SHALL STOP/START FAN BASED UPON OCCUPIED/UNOCCUPIED MODE. WHEN FAN IS RUNNING, EXHAUST DAMPER SHALL BE OPEN. WHEN FAN IS OFF, DAMPER SHALL BE CLOSED.

KCK TEMPERATURE CONTROL REQUIREMENTS	
1.	C&C GROUP IS THE APPROVED DDC CONTROL SYSTEM PROVIDER. ALL CONTROLS INSTALLED FOR THIS PROJECT SHALL BE OPEN PROTOCOL TO INTERFACE WITH LON OR BACNET BASED SYSTEMS. NO PROPRIETARY SYSTEMS ALLOWED.
2.	THE CENTRAL BAS SYSTEM LOCATED IN THE DISTRICT SHOP SHALL BE MODIFIED BY C&C GROUP TO ADD THESE CONTROLS AND POINTS. CONTRACTOR TO INCLUDE ALL PROGRAMMING NECESSARY.
3.	TEMPERATURE SENSORS USED FOR THIS PROJECT SHALL NOT DISPLAY READOUTS.
4.	PROVIDE TEMPERATURE MONITORING OF THE DATA ROOM CLOSETS. REPORT ALARMS ON HIGH (80°F ADJ) AND LOW (60°F ADJ) TEMPERATURES.
5.	THE DDC SYSTEM SHALL PROVIDE DIAGNOSTIC CONTROL STEPS TO ALLOW KCK PERSONNEL TO TROUBLESHOOT THEIR SYSTEM FOR RTU'S PROVIDE CONTROL TO COMMAND O.A. DAMPER OPEN/CLOSED, ENGAGE COMPRESSOR(S), ENGAGE HEAT AND START/STOP FAN.

TEMPERATURE CONTROL SYMBOLS			
DO	DIGITAL OUTPUT	LS	LIMIT SWITCH
DI	DIGITAL INPUT	FS	FLOW SWITCH
AO	ANALOG OUTPUT	DP	DIFFERENTIAL PRESSURE SENSOR
AI	ANALOG INPUT	SP	STATIC PRESSURE SENSOR
LAT	LEAVING AIR TEMPERATURE	DATS	DISCHARGE AIR TEMPERATURE SENSOR
EAT	ENTERING AIR TEMPERATURE	MATS	MIXED AIR TEMPERATURE SENSOR
RA	RETURN AIR	CT	CURRENT TRANSDUCER
SA	SUPPLY AIR	STG	STAGE OF HEATING/COOLING
OA	OUTSIDE AIR	S/S	START / STOP
LWT	LEAVING WATER TEMPERATURE	DM	DAMPER MOTOR
EWI	ENTERING WATER TEMPERATURE	NC	NORMALLY CLOSED
CHW	CHILLED WATER	CO2	CARBON DIOXIDE
CWS	CHILLED WATER SUPPLY	VOC	VOLATILE ORGANIC COMPOUNDS
CWR	CHILLED WATER RETURN	DX	DIRECT EXPANSION
HW	HOT WATER	VFD	VARIABLE FREQUENCY DRIVE
HWS	HOT WATER SUPPLY	FAC	FIRE ALARM CONTROL PANEL
HWR	HOT WATER RETURN	CTRL	CONTROLLER
		AFMS	AIR FLOW MEASURING STATION

ISSUED FOR:	
DESCRIPTION	DATE
1	
2	
3	

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DRAWN BY:  
 CHECKED BY:

SHEET TITLE:  
 MEP CONTROLS

DATE: **02/07/22** PKMR PROJECT: **21.659C**

SHEET NUMBER: